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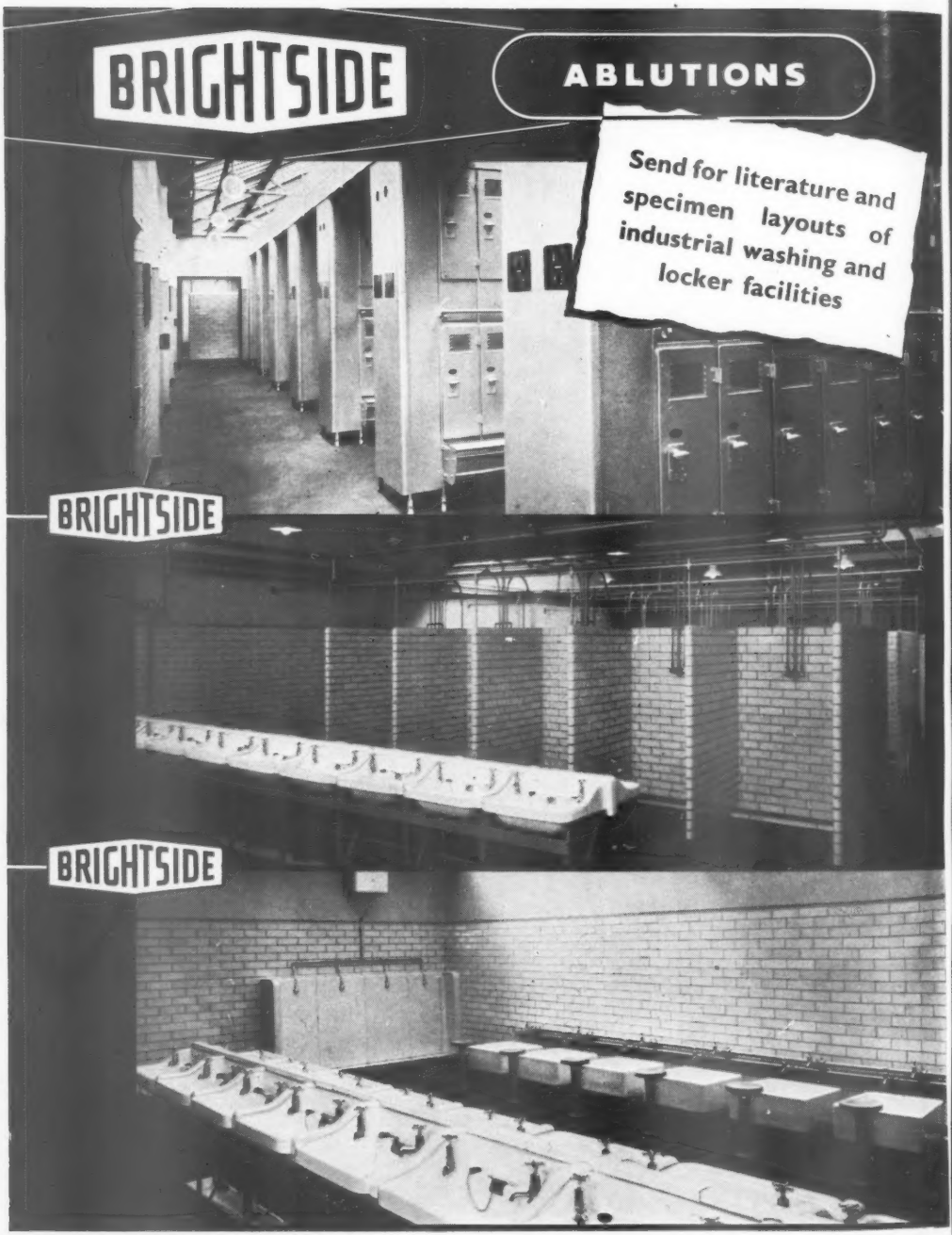

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Keep the Home Fires Burning — Properly!

The basic welfare of the home depends entirely on the efficiency of the facilities for proper heating of the rooms; the provision of an adequate supply of hot water and the existence of reliable cooking apparatus. The foundry industry has responded well to these requirements and an excellent range of apparatus is available. In some, but not all, cases the servicing of these appliances is excellent, but far too often the equipment manufacturer is badly "let down" by poor installation. Many firms issue instruction pamphlets for the proper installation of their apparatus, yet cases are reported of the employees of local builders completely ignoring them, coupled sometimes with an exasperating comment from the fitter that the installation might or might not be satisfactory.

The inertia of architects and builders has necessarily to be overcome, because at the moment, as the result of the Beaver Report, much attention is to be paid to all those domestic appliances burning solid fuel. The Report carries a recommendation for the standardization of this class of fuel, which measure should be of some help—the availability of supplies being assumed—in the design of domestic apparatus. Yet the fuel-burning equipment manufacturers need in many cases more intelligent support from the architects and builders.

The Coal Utilisation Council, through its Training Centre, conducts courses for the staff of builders, builders' merchants and the like, which provides the type of instruction they need, if adequate service is to be given to the householder. Equipment manufacturers should insist on their agents participating in this course.

In the recent re-imposition of regulations concerning hire-purchase agreements, the acquiring of domestic heating apparatus was rightly more generously treated than radio and television. The importance of domestic heating apparatus should likewise be reflected in the attitude adopted by the householder. If a television or radio is bought and is unsatisfactory, the seller has no rest until the instrument is in working order; a breakdown creates a similar activity. Yet if a stove designed to burn continuously fails to last overnight, the fuel is blamed or some other excuse put forward, but the householder just "puts up" with the position and "talks." One prominent company in the appliance industry has recognized this and has taken steps to ensure that when a customer talks it is always to the credit of the apparatus. This mental attitude must be created within the whole of the domestic equipment industry. It starts with supervising correct installation and ends with continuous and enlightened service to the user, such as the community has learnt to expect from the radio industry.

Leaders of the Industry

ALFRED FREDERICK RAYNER

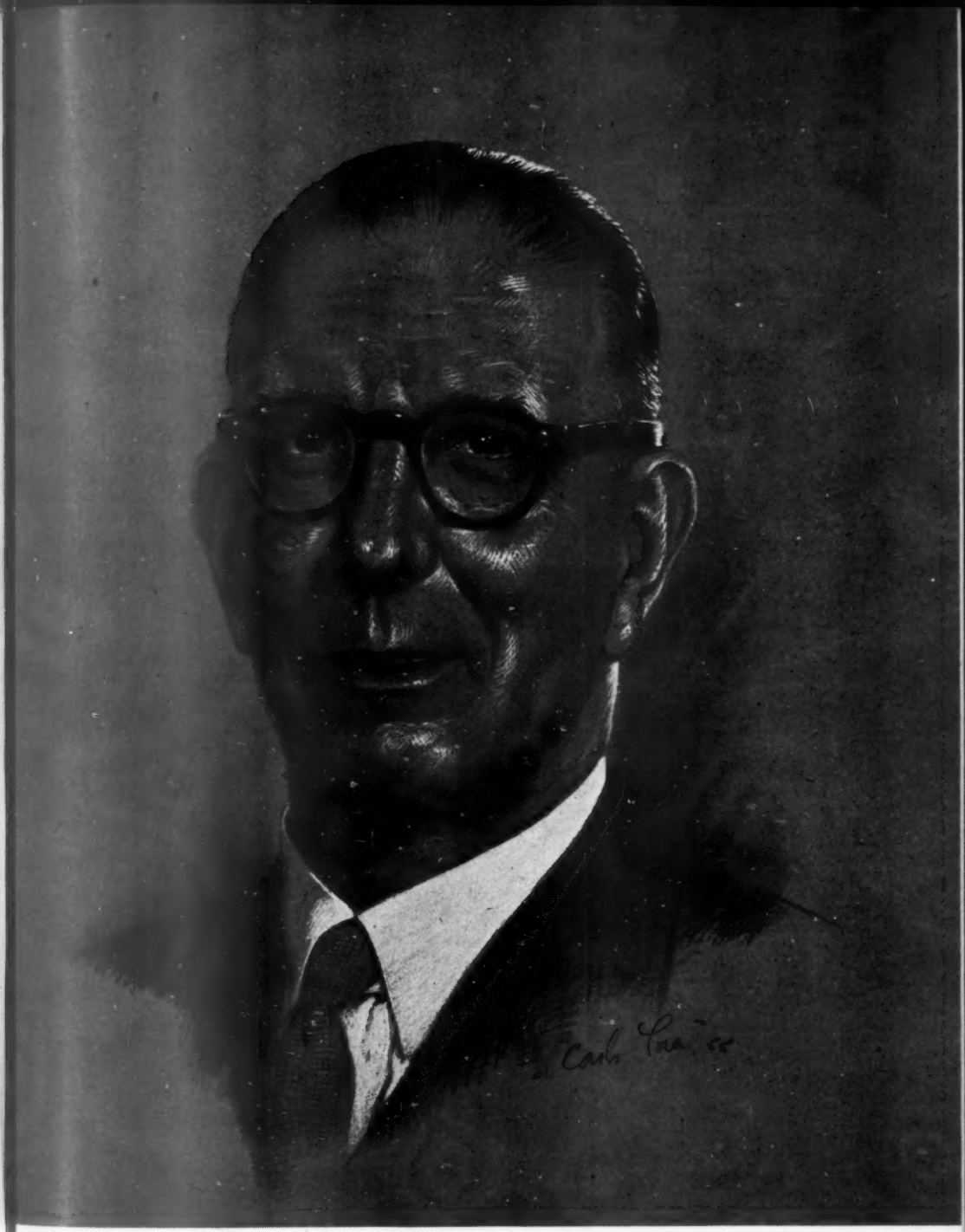
IF Mr. A. F. Rayner had pursued an early ambition to follow a legal career, the non-ferrous foundry industry would have been poorer in leadership, as he is this year's popular president of the Association of Bronze and Brass Founders. However, fortunately for us, as a young man, he was attracted to the more interesting job of making things.

Like the youth of his day—he was born in 1889—Mr. Rayner devoted his evenings to the acquisition of technical and commercial knowledge by study in London's excellent schools and colleges. Before he was 21, he joined the London office of the Anti-Attrition Metal Company, Limited, and a few years later was appointed accountant. Then, in 1926, he was appointed secretary, thus following in the footsteps of the chairman of the company, Mr. S. P. Loosen. A seat on the board came in 1934 and since then he has been appointed chairman of Brecknell, Willis & Company, Limited, engineers and ironfounders of Chard, Somerset, and is on the board of other associated companies.

As is the case with many busy executives, Mr. Rayner has always found time to serve the public. He has been a member of the Territorial Army, the Special Constabulary and the Home Guard. Attaching great importance to the future personnel of his company, his firm has organized as successful an apprentice scheme as exists amongst the non-ferrous foundry industry. A fine house has been acquired as a hostel and a high-grade type of boy has been attracted.

His duties this year as president of the Association of Bronze and Brass Founders are not light, as the Association has undertaken a scheme of according technical help to all the plants in this branch of the foundry industry. Moreover, there are included among his engagements the representation of the Association on educational bodies and participation in the work of numerous committees.

Mr. Rayner is a Freeman of the City of London. One of his hobbies is the reading of technical journals and the study of statistics, and when surfeited with these he supervises the gardening activities at his home, or for a change, takes the dog for long country walks.



A. F. RAYNER.

President of the Association of Bronze and Brass Founders.

Industry and the Atomic Age

In the White Paper on the programme of nuclear power in the next decade it was stressed that private industry would build the nuclear power stations for the electricity authorities. Industry has already taken up the challenge.

Preliminary studies will be carried out by a team of specialists from John Thompson, Limited, and the Metropolitan-Vickers Electrical Company, Limited, and the British Thomson-Houston Company, Limited, which are the two companies in the AEI group particularly concerned.

The English Electric Company, Limited, has also gathered a group of experts to work on the design of complete nuclear power stations. The company is, of course, concerned already with the electrical equipment of the Calder Hall station. In addition, it has formed a special atomic energy division.

An industrial atomic energy section has also been formed by the General Electric Company, Limited. Mr. R. N. Millar, lately chief mechanical engineer of the British General Electric Company (Pty.), Limited, Australia, has been appointed to take charge of the new organization, which is located at the company's Erith (Kent) works. It is again intended to provide most of the equipment for atomic power stations from within the company's own manufacturing organization.

Output Drive in Scotland

The effort to increase industrial productivity in Scotland is to be increased in the spring and early summer. Sir Ewart Smith, chairman of the British Productivity Council, will address two meetings this month—in Edinburgh on March 16 and in Falkirk on March 17. In April, the Council's industrial engineering team will visit all 12 areas in which local productivity committees are operating. It is proposed to set up another committee in the Dumbarton area. A preliminary meeting is to be held at Dumbarton on March 7. Thereafter the Council hope to begin operations in the Border counties.

Sir Ewart Smith, who has been technical director of I.C.I. Limited since the end of the war, was appointed deputy chairman of the company at the end of January. His name is particularly identified with the expanding use of work-study. I.C.I. have made conspicuous progress in the development and application of this technology and have put the results of their experience freely at the disposal of the rest of industry.

Dinner

AGA HEAT AGENTS CONFERENCE

Mr. V. Jobson presided over the annual dinner of Aga Heat, Limited, which was held at the Dorchester Hotel last Wednesday. With him at the top table were Mr. A. H. Masser; Mr. J. Stanleigh Turner, J.P.; Mr. James Shaw; Mr. W. T. Wren; Mr. Eric Bellingham, O.B.E., LL.D.; Mr. R. G. Elliot; Mr. W. H. Smith; Mr. A. E. Wright; Mr. A. Sykes; Mr. H. C. Wilson Bennetts; Mr. R. L. Hunter; Mr. H. V. Shelton; Mr. R. G. Leach; Mr. R. J. Moffat, M.B.E.; Mr. R. A. Sherman; Mr. T. O. Lander; Mr. W. J. Hoad (New Zealand); Mr. Noel J. Crowe; Mr. K. C. Bowyer; and Mr. C. Insch. After dinner the guests were entertained by a cabaret.

Correspondence

EXPANSION-TYPE SCAB FORMATION

To the Editor of the FOUNDRY TRADE JOURNAL.

SIR,—As one of the contributors to the numerous explanations of scab formation based on foundry research, I am interested in the "hypothesis" given in the article in the February 17 issue of the JOURNAL.

Having thought about it, I am of the opinion that if the graphitization causes internal pressure sufficient to burst the thin casting shell and extrude the low-melting-point "mother liquor," it is difficult to see how the extruding liquid can penetrate the mould with sufficient force to undermine the surface and on its return journey burst the skin inwards against the pressure from which the stream originated. It would appear more reasonable to say that the formation of the scab (by whatever means) was the cause and the leakage of metal through the casting skin the effect.

If the scab is caused at a point of excessive heating this would exaggerate both the expansion and gas pressure near the mould surface and strengthen both these explanations rather than refute them.—Yours, etc.,

W. Y. BUCHANAN.

John Lang & Sons, Limited,
Johnstone.

EASTERN TEA KETTLES

To the Editor of the FOUNDRY TRADE JOURNAL

SIR,—Following my illustrated note in your issue of February 4, 1954, on two eastern cast-iron tea kettles, I supplied Dr. G. Ohira, of Tohoku University, Sendai, with a copy of the inscriptions respectively on the inside of the lid and on the body of the left-hand kettle in the photograph.

Dr. Ohira reports that the inscriptions are identical, and refers to the name and location of the maker. Both kettles are Japanese and probably date from the end of the last century. From catalogues sent by him it appears that these kettles are in current manufacture and over a hundred designs of kettles and other vessels for domestic use are illustrated. The queries which ended my note are, thanks to Dr. Ohira, thus very satisfactorily answered.—Yours faithfully,

J. G. PEARCE,
Director.

British Cast Iron Research Association
(Incorporated 1921).
February 23, 1955.

Fuel-efficiency Conference

The National Industrial Fuel Efficiency Service, in conjunction with the Combustion Engineering Association, is taking the opportunity afforded by the forthcoming third National Factory Equipment Exhibition, March 28 to April 2, to hold on the second day, in the Richmond Hall at Earls Court, a conference entitled "Fuel Efficiency Pays." The speakers will include J. Rylands, J.P., M.SC., on "Reducing Steam-raising Costs"; J. R. Wheating, B.A. (CANTAB.) (of W. H. Allen & Sons & Company, Limited), on "Economics of Power Supply"; Sir Oliver Lyle, O.B.E. (Tate & Lyle, Limited), on "Steam Saving Pays"; and W. Jenkins (director of John Wright & Sons (Veneers), Limited, and of the National Industrial Fuel Efficiency Service), on "NIFES Contribution to Fuel Efficiency." Further details may be obtained from the Joint Conference Office of NIFES and the CEA at 6, Duke Street, St. James's, London, S.W.1.

Melt-quality Tests for Copper-base Alloys*

By A. R. French, A.I.M.

After an historical introduction, the Author describes how testing of melt and metal quality was first conceived, passing on to relate the applicability of pre-pouring tests to the main alloy groupings—high-tensile brasses, aluminium bronzes, and copper/tin alloys (including leaded gunmetals). Testing in each group is examined from the standpoints of (a) service properties desired (b) metallurgical characteristics of the particular alloy, and (c) factors which influence these characteristics. This leads to a discussion of suitable tests to apply in each circumstance. A note is included on reported American methods of melt-quality assessment. Influence of gas absorption and mode of solidification are given as primary considerations when assessing the value of tests applied, and these, in turn, are linked to economic factors governing the operation of non-ferrous foundries.

Introduction

The history of the founding of copper-base alloys is indeed an interesting one. It is said that by 3,000 B.C. the advantages of alloys of copper and tin had been realized in India, Mesopotamia, Asia Minor and Greece, and in fact the alloys had come to be regarded as a necessity. By 2,500 B.C. bronze was regarded as vital to the making of armaments. It is interesting to note the view expressed that the high cost of bronze tools and arms influenced the trends and development of early civilization. Somewhere between 2,000 and 3,000 years ago, the Bronze Age spread to central Europe and Britain. The metal remained rare and costly for centuries, and was used exclusively for weapons and ornaments: the tools used by those other than metal workers remained those of the Stone Age. The earliest examples of brass were found in ruins dating back to 600 B.C. and were probably made initially by the Romans for coinage. For several centuries brass had a higher value than that of bronze, but later, and even to the present day, the terms "brass" and "bronze" have been frequently confused.

Apart from a relatively small use of brass, the alloys used in historical times were based essentially on copper and tin. In more recent years, from the time of the industrial revolution, the alloys bronze and brass have been those mainly used by the vast majority of non-ferrous founders. It would appear that it was during the latter half of the last century, after some 3,000 years of bronze making, that the test-bar was introduced as a routine melt-quality test. It was also during this period that the high-strength aluminium-bronzes and high-tensile brasses (known also as manganese-bronzes) were introduced. It is interesting to note that these recently introduced alloys have—until almost the last decade—been left alone by the general foundryman as being difficult to cast and to be made only by the specialist. In point of fact, it can be regarded as fortuitous that it has been found easier to produce satisfactory castings in the copper/tin alloys than in the high-tensile brass alloys. It is far more difficult fully to understand the effects of the variables which can arise in the foundry with the copper/tin alloys than it is with the aluminium-bronzes and high-tensile brasses.

* Paper read before the London branch of the Institute of British Foundrymen; subsequently also to the Beds. and Herts. section. The presentation was in each case accompanied by the showing of two short films.

Entry of the Metallurgist

In the light-alloy field, the co-operation of the metallurgist in the foundry was a necessity almost from the beginning, at about the turn of the century, because of the metallurgical complexity of the alloys, and because of the rigid requirements of the users of light-alloy castings, particularly in more recent years those of the aircraft industry. In the copper-alloy field, however, it was not until after some 3,000 years of the use of these alloys—with the development of the high-tensile copper alloys, when it was of the utmost importance to ensure satisfactory alloying, to control the composition during melting, and to devise special foundry techniques to avoid oxide inclusions—that the metallurgist entered the bronze foundry. It was at that time that there was the first evidence of pre-casting melt-quality tests being introduced. Even then, the vast majority of copper alloy castings made were based on copper/tin, and in this group the foundry craftsman carried on with his long-established alloys alone.

During recent years, however, many problems have arisen in the requirement to manufacture castings of more complex form, attaining higher degrees of pressure-tightness, maintenance of scrap at a low level, and, last, but by no means least, the production of test-bars the results of which would satisfactorily meet inspection requirements. Foundrymen and metallurgists have realized that they can help one another in this field and it is at this relatively late date that thought has turned to melt-quality tests to be used before casting for alloys based on copper/tin.

Difficulty with Copper/Tin Series

Coincident with this introduction of the metallurgist into the more general affairs of the bronze foundry, he has found that, although the high tensile

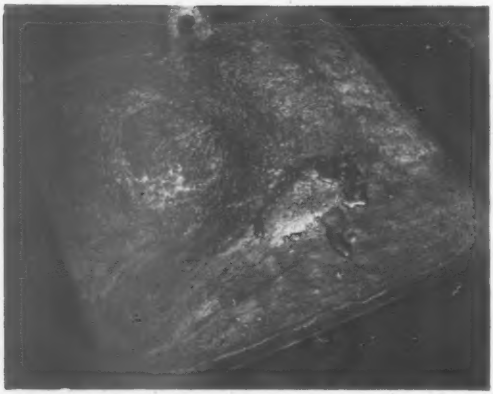


FIG. 1.—*Top surface of a 1-ton ingot of high-tensile brass (tin in excess of 1 per cent.) in which gas inclusion has caused pronounced inverse segregation.*

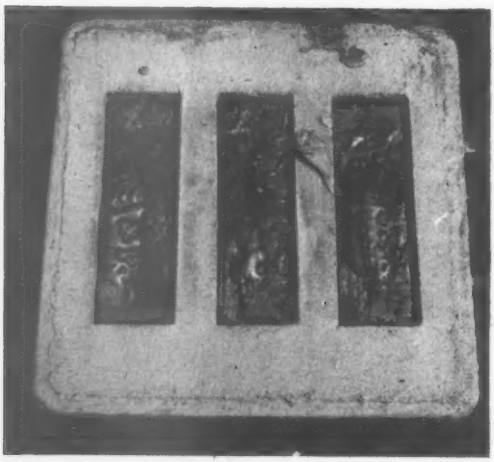


FIG. 2.—*Top surfaces of a moulding-box complement of standard test-bars, cast in an alloy similar to Fig. 1.*

alloys are complex and necessitate close control metallurgically they readily respond to logical scientific treatment in the foundry; to the contrary, the copper/tin alloys, relatively simple to understand metallurgically, are far more complex and difficult to understand in the foundry. It is during the past two decades that it has been shown how important is a small amount of dissolved gas in these alloys for the production of satisfactory castings, and it is undoubtedly to this feature that one can attribute the fact that castings have been produced satisfactorily throughout the centuries.

For more than half a century, melt-quality tests have been applied after pouring, in the form of chemical analyses and the casting of test-bars for checking mechanical properties. It is interesting that, while to-day there is little difficulty in producing three test-bars from the same heat of high-tensile brass or aluminium-bronze to give consistent results which are truly representative of those which the alloy is capable of giving, with the copper/tin alloys there is still the greatest difficulty in producing consistent results from the same heat, and it is very doubtful whether these results are representative of those which the alloy is capable of giving.

Groupings

It is neither possible in the space of this Paper to consider all the various alloys individually, nor to consider the more-specialized alloys such as chromium bronzes and the heat-treatable copper/chromium and beryllium/copper series. It is proposed to discuss first the high-tensile brasses and then the aluminium-bronzes, for which test-bar results can be reliably obtained and for which melt-quality tests prior to pouring are now well established. Attention will then be turned to the copper/tin alloys, and there will be some discussion of the test-bar problem and the problem of devising a suitable melt-quality test for use prior to casting with particular reference to leaded gunmetal.

In order to decide what are suitable melt-quality tests, it is necessary to consider first the desired service properties of the alloy being cast, second the metallurgical characteristics of the various types of alloys to which these properties are related, and third the factors which influence these characteristics. Each section will therefore be treated in this order, leading into a discussion of suitable melt-quality tests.

HIGH-TENSILE BRASSES

A high-tensile brass is selected for making a casting because of its strength and corrosion resistance, and because it can be readily cast into complex or very large forms which can be easily machined to give surfaces that will take a high finish. The important properties and the control of the grain-size are obtained by additions of aluminium, tin, iron and manganese, and by controlling the final proportion of the alpha and beta phases in the microstructure.

Ingots

To make satisfactory ingots of high-tensile brass involves the careful alloying of the copper, iron and manganese, and the thorough mixing of the aluminium, tin and zinc. It is also necessary to avoid the introduction of deleterious impurities at this stage. If secondary materials are being melted for the manufacture of ingots, then it is also necessary to avoid the introduction of excessive amounts of impurities, although probably in this case the most common are nickel and lead—nickel is, of course, sometimes a deliberate addition, in which case the basic composition is suitably adjusted to accommodate it. It is possible at this stage to pick up gas in sufficient quantities to cause the ingot surfaces and the

test-bar surfaces to rise, but this would not normally influence the metal when it is subsequently remelted for casting, as the gas would be lost during remelting. This inclusion of gas usually arises from melting in furnaces in which the metal is in direct contact with the flame or furnace gases, as in reverberatory furnaces, particularly when fluxes are used to reduce melting losses. This gas can produce a pronounced inverse segregation effect in the ingots, which is particularly aggravated by the presence of tin of the order of 1 per cent. or more. Figs. 1 and 2 illustrate these effects in the case of a 1-ton ingot poured from metal melted in a reverberatory furnace under flux, and in a box of standard test-bars; in each case the tin content was in excess of 1 per cent.

Castings

High-tensile brass alloys have a very short solidification range—of the order 15 deg. C. They exhibit considerable solidification shrinkage, which necessitates a suitable foundry technique being used to ensure directional solidification, with adequate arrangements for feeding. These alloys, like the aluminium-bronzes, are prone to the formation of oxide, and it is therefore necessary to devise a running system which will avoid turbulence during pouring. If the foundryman has the necessary experience properly to design the running and feeding systems for the casting, then whether or not the casting will be satisfactory for the purpose for which it is required will depend on the metallurgical control of the alloy up to the time that it is ready for pouring. The presence of dissolved gas in the metal picked up during melting is not normally an important factor, unless the casting is large and the time for solidification is sufficiently prolonged for inverse segregation effects to occur; again it is only those alloys relatively rich in tin which are seriously affected in this case.

Melt-quality Tests

Two basic melt-quality tests can be applied prior to casting to achieve the necessary control over the composition of these alloys. The first is referred to as the "fracture-bar" technique devised more than half a century ago and described earlier in the proceedings of the Institute,[1] and the second is the "sand-bar" technique.

Fracture Bar.—In the fracture-bar technique, when the metal is ready for pouring, a sample is poured into a chill mould as shown in Fig. 3. The metal is allowed to remain in the mould for 15 sec., and the cast bar is then knocked out. It is picked up with tongs, held in air for 45 sec., and then carefully quenched by dipping alternate ends into water, progressively more each time until the whole bar is immersed, the quenching process taking 30 to 45 sec. The bar is then placed on the floor and nicked in the centre with a cold chisel. The bar is then turned over, laid between suitable supports, the cold chisel appled to the surface over the nick and the bar broken by a blow with a sledgehammer. It is essential to control carefully the times of the various operations, as any serious deviations from these times can lead to misleading results.

The fracture is examined under a magnifying glass, and from the colour and "sparkle" characteristics, the amount of zinc which it is necessary to add to produce the desired proportion of alpha to beta constituents in the final alloy can be estimated. With the necessary experience, the alloy can be brought to within 5 per cent. alpha (approximately ½ per cent. zinc) of the required amount. The precise appearance of the fracture at the desired composition will depend upon the alloy and the properties required, but when working with one or two alloys which are under good control of composition, it is quite easy to acquire the required experience to produce satisfactory results. In all cases the "sparkle" increases as the zinc content increases, or, in other words, as the alpha content of the final alloy decreases. With regard to colour, the lower the zinc or the higher the alpha constituent in the final alloy, the more yellow the appearance of the fracture. [Here a coloured slide was exhibited of typical fractures.]

FIG. 3.—*"Fracture-bar" mould and test-piece for high-tensile brass.*

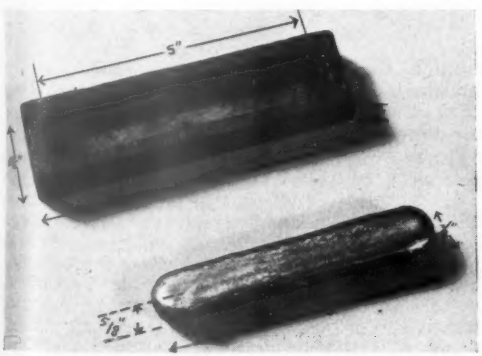
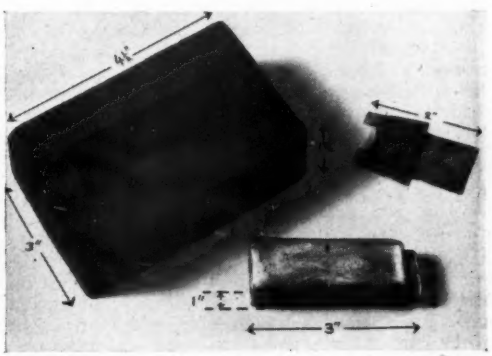


FIG. 4.—*Sand-bar mould—made in core-sand—and test-piece obtained; the mould insert to facilitate the cutting of a microsection is shown top, right.*



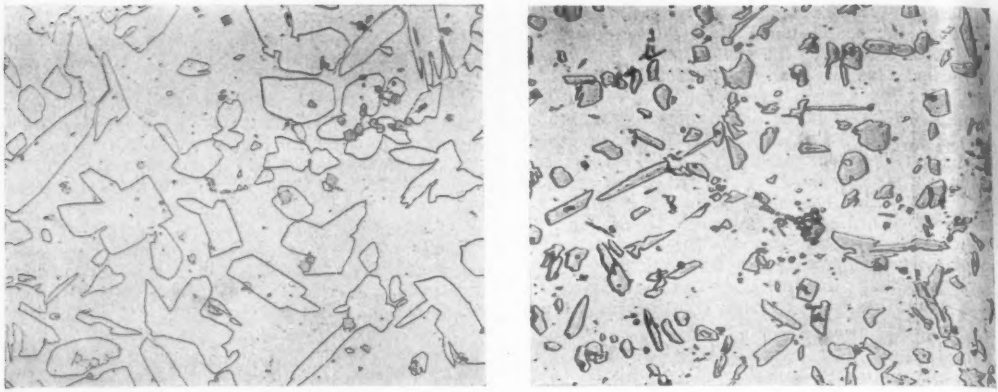


FIG. 5.—*Typical photomicrographs of high-tensile brass, etched in ammonia/ammonium-persulphate; (a) (left) ×250; (b) ×75.*

Ductility

Another guide in connection with low zinc is the amount of ductility exhibited by the bar when broken. If it bends significantly, then it is probably very low in zinc and the fracture would be very yellow in appearance, as distinct from the normal more pink colour required; also, with such a low zinc value there would probably be no "sparkle" to be seen. It is wise to add not more than 2 per cent. zinc at a time, even though it is considered that the alloy is deficient to a greater extent than that, and, of course, it is essential that after each addition is made, the metal should be thoroughly mixed with an upward and downward motion. After each addition, a further fracture-bar test is taken until a satisfactory result is obtained. With satisfactory melting practice, it is not normally necessary to add more than ½ or 1 per cent. zinc, and with an experienced man in the foundry for "speltering," as it is known, it is not necessary to take more than the one fracture bar.

Sand Bar.—The "sand-bar" test takes a much longer time to operate than the fracture-bar and can therefore be used as a pre-pouring test only when a large bulk of metal is concerned; it would not normally be considered suitable as a pre-pouring test for metal melted in crucibles. This test, however, can be used as a quick check after casting, if that be required.

The method is to take a sand mould (normally made in core-sand so that a stock of the moulds can be maintained) with an open top, to provide a bar 3 by 1 by 1 in. (Fig. 4). The metal is cast into the mould and allowed to stand for 15 min. The bar is then knocked out and quenched. A small microsection is cut and quickly prepared and etched for the estimation of the proportion of alpha to beta constituent. To facilitate the cutting of the microspecimen, either a small piece can be cast on to the end of the bar of about ½ in. square section and of length equal to the full width or height of the bar, or again, as a further refinement, a small metal piece can be cast in to produce a notch effect so that the microsection can be broken off in a vice.

Alpha : Beta Ratio

The percentage of alpha constituent in the microstructure can, of course, be measured, but this takes a considerable time and with experience it is possible to estimate it very closely, to within 5 per cent.: The normal procedure is to estimate by eye before casting and to measure it as a check and for record purposes afterwards—an attachment for the microscope stage to facilitate this measurement has been described.[2] The amount of alpha constituent required in the casting is known. In very large castings, there is a difference of about 10 per cent. between the alpha content of the sand bar and the alpha content of the casting, the casting of course having the higher amount. As a close approximation for small additions, 1 per cent. of zinc can be taken to be equivalent to a reduction in alpha content of 10 per cent. To be more precise, 1 per cent. of zinc is equivalent to about 7 per cent. of alpha, and in the event of large additions of zinc being required it is necessary to take into account that the zinc addition added to the total charge when calculated as a percentage is only about half the amount required. It is, however, never advisable to make a very large addition of zinc without taking a further check, and, of course, the metal can be brought to within a close approximation of the required amount by the fracture-bar technique before using the sand-bar method for final adjustment.

The two methods described take into account all those elements which influence the final proportion of alpha to beta constituent in the microstructure. The sand-bar method, involving the examination of the microstructure, also gives information concerning the amount of the iron phase present, the amount of lead, and the presence of other impurities which influence the microstructure. With certain compositions, it is also possible to have the gamma phase present, which can be clearly seen at this stage. In

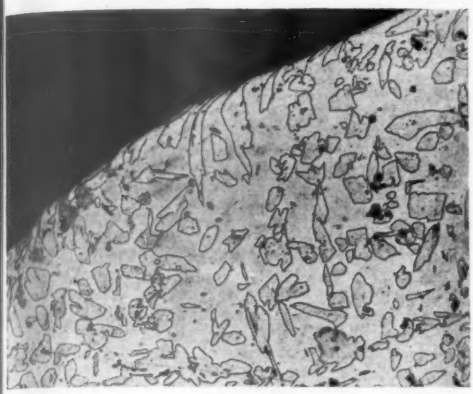


FIG. 6.—*Deflection of alpha phase at the surface, caused by surface flow during machining with a blunt tool.* ×50.

this connection it is advisable that the specimen be etched with ammonia/ammonium persulphate etchant rather than acid/ferric-chloride. The reason for this is that, when using ferric chloride, the iron phase is darkened and it is difficult readily to distinguish between iron and lead, whereas with the ammonia etchant the iron phase remains light and the lead dark (Fig. 5(*a*)). It is also considered that, with this etch carefully controlled to produce the maximum contrast between alpha and beta, the estimation of the alpha content is facilitated (Fig 5(*b*)).

Copper Determination

A quick copper determination has sometimes been recommended and, in fact, is actually used as a means of estimating the loss of zinc during melting. This is, of course, satisfactory, provided that the basic composition, particularly with regard to aluminium, is very close to the nominal specification. If it were not so, then a small zinc addition would be made to compensate for a small deficiency in aluminium, and as the zinc equivalent of aluminium is about 5 or 6, according to the amount present, then a very significant discrepancy would arise in the proportion of alpha to beta present in the final alloy. It is considered that this method is by no means as satisfactory as the other methods described.

In the case of checking ingot metal, the sand-bar has much to recommend it. In checking virgin ingot, any improperly-alloyed metal is quickly disclosed and, in fact, in the case of checking remelted secondary metals the inclusion of any improperly-alloyed metal in the charge would also be disclosed. It is, of course, always necessary to ensure thorough mixing before taking a sample, whether for a sand-bar or a fracture-bar test. Against the possibility of inefficient mixing, it is good practice to take fracture bars, sand bars, or both, at the beginning and end of pouring the ingots. The fracture bars can be broken on the spot and any inefficiency in mixing will be immediately revealed. In a case of doubt in the examination of the microstructure using the first sand bar, a check can be made on the final sand bar to see whether there is in fact a deficiency in the metal as a whole, or whether it is a case of bad mixing.

Work Hardening

The melt-quality tests normally applied after casting are the determination of the chemical analysis and mechanical properties, which are also related to composition. An interesting small, but nevertheless important, point which can influence the results of test-bars is the possibility of work-hardening the surface. It has been found that if a blunt tool is used, a surface layer to a depth of some 0.004 in. can become work-hardened, and this can result in properties being obtained as much as 1.0 ton per sq. in. and 10 per cent. elongation lower than the true result (the effect is shown by the deflection of the alpha particles in Fig. 6). This is considered to be due to the occurrence of small cracks in the surface layer when the limit of ductility of the work-hardened material is reached, one of these cracks then being rapidly propagated across the entire section.

The presence of iron in an unsatisfactorily alloyed condition is not necessarily disclosed by tensile tests or chemical analyses, but would be readily disclosed using the sand-bar method. It is considered that, in the hands of an experienced metallurgist, the sand-bar technique is invaluable and enables him to identify quickly most of the abnormalities which can arise in the material, far more, in fact, than would be disclosed by tensile tests or chemical analyses.

(*To be continued*)

MINERAL PRODUCTION in Northern Rhodesia during December was valued at £10,138,457, this monthly total having been exceeded only once previously—in June, 1953. The annual figure of £97,507,961 for 1954 created a new record, exceeding by more than £2,500,000 last year's value of £94,950,978.

Output of blister copper totalled 204,975 tons, valued at £48,007,900; electrolytic copper, 173,636 tons (£43,132,746); zinc, 26,550 tons (£2,075,193); lead, 15,000 tons (£1,445,688); cobalt, 11,762 cwt. (£1,383,218); and cobalt alloy (39.5 per cent. cobalt), 21,267 cwt. (£965,206).

ALUMINIUM CASTINGS COMPANY, LIMITED, Ingleston Foundry, Greenock, have bought the Canadian Government's plant at Renfrew, Ontario, hitherto operated by Cockshutt Aircraft. A new subsidiary of the Scottish company will be formed in Canada and take over the factory, which produces jet engine components, at the end of this month. In addition to the production of general engineering castings at Greenock, the company have works at Larkhall, manufacturing aluminium holloware. Among subsidiaries in other parts of the UK are Burnley Aircraft Products, who produce jet engine components.

Head, Wrightson Ceremony

In 1839, the first cotton mill in the north of England was built at Thornaby-on-Tees. Unfortunately, the venture did not last very long and the building was acquired by Head Wrightson & Company, Limited, and used for many years as a machine-shop. In 1949, there was a disastrous fire and the building was burned down. On clearing up the debris, a commemoration tablet was found in the foundation stone together with some examples of plates from Thornaby Pottery of 1839 period. Head Wrightson is now building a new extension to the office block and the chairman and managing director, Mr. Richard Miles, thought to perpetuate the idea of the founders of 1839 and a pleasant little ceremony was held on Wednesday, February 9, when Gwen, Lady Wrightson, widow of Sir Guy Wrightson, a former chairman of the company, laid a casket beneath the foundation stone of this new extension. Amongst the articles in the casket were a selection of coins, copies of "The Times" and local newspapers, the firm's medallion, a copy of Thornaby Town Council Minutes, a copy of the firm's magazine and several booklets outlining the firm's activities, and a matchbox.

Attending the ceremony with Lady Wrightson were Mr. and Mrs. Richard Miles, Sir John Wrightson, vice-chairman and deputy managing director, Mr. Peter Wrightson, deputy managing director, Mr. K. W. Hickman and Lord Ridley, directors, Mr. R. N. Allison, secretary, Mr. Frank Shepherd, personnel manager, and other management representatives. Councillor J. N. Scott attended both as Mayor of Thornaby-on-Tees and as an employees' representative on Head Wrightson's works council. He was accompanied by the town clerk of Thornaby, Mr. A. Stockwell. A bouquet was presented to Lady Wrightson by one of the firm's youngest apprentices.

It is expected that the new office block will be complete by July of this year and it will accommodate the firm's personnel department, the engineering division, the secretarial staff, and directors' offices. On the top floor will be a new board-room.

Overseas Trade Inquiries

Details of trade inquiries made by companies overseas concerning British manufactures are given below. Unless informed otherwise, interested manufacturers are advised to communicate (by air mail if stated) with the inquirer at the address given. At the same time they are requested to notify the local overseas representative of the UK Government, whose address is also given below, of any action taken. Any correspondence with the Export Services Branch of the Board of Trade, at Lacon House, Theobalds Road, London, W.C.1 (telephone: CHAncery 4411, extension 776), should bear the appropriate BOT reference, which is quoted in parentheses at the end of each inquiry.

KINGSTON INDUSTRIAL AGENCIES, LIMITED, 14, Darling Street, Kingston, Jamaica, wishes to represent a UK manufacturer of high-pressure steam water valves. Notify the UK Trade Commissioner, Royal Mail Building (PO Box 393), Kingston, Jamaica. (ESB/3325/55.)

MR. MAURICE WIDE, PO Box 1136, Salisbury, Southern Rhodesia, wishes to represent UK manufacturers of small machine tools, motor car tools, and trowels. Notify the UK Trade Commissioner, Sanlam Building, Salisbury, Southern Rhodesia. (ESB/7439/54.)

PIPE-FITTING INDUSTRIES, LIMITED, PO Box 365, Badamibagh, Lahore, Pakistan, wishes to receive quotations from UK suppliers of plant for producing tees, elbows, bends, sockets, flanges, nipples, etc., from ¼ in. to 3 in. Notify the UK Trade Commissioner, PO Box 287, National House, Bank Square, The Mall, Lahore. (ESB/2665/55.)

British Standard for Control-chart Technique

A new British Standard (BS 2564: 1955) gives practical guidance on the use of quality control in all processes of manufacturing to a specification. Written by Dr. B. P. Dudding and Mr. W. J. Jennett, it was first published by the General Electric Company, Limited, in 1944, and with the kind permission of the GEC it is now issued as a British Standard. The same authors intend to supplement BS 600R, which is already well known for its description of the statistical principle and methods used in quality control. The new standard is essentially a practical manual describing procedures which have been found acceptable when introducing and operating quality control methods as factory routine. Its major object is to assist production to a standard of quality, with the elimination of waste of labour and material.

The standard is divided into two parts. The first concerns the utilization of results of measurement (quantitative data) and is of particular interest to manufacturing industry wherever articles or components are produced in quantity with dimensional limits of accuracy. The second part concerns the classification of a product by quality (qualitative data) and it is of use wherever sampling technique can be applied to regulate production. The standard will be of interest also to those who are teaching the use of statistical methods. Directions are given for the construction and interpretation of control charts appropriate to various types of process and examples of some of the different cases met in practice are given. Copies of the standard may be obtained from the British Standards Institution, Sales Branch, 2, Park Street, London, W.1 (price 10s. 6d.).

Modernization at Northern Aluminium

The Banbury Works of Northern Aluminium Company, Limited, is now carrying out a modernization programme planned to increase the output of sheet and strip by several hundred tons annually. Extensive remodelling of the remelting facilities is already under way to achieve this. The project is being undertaken at a time of steadily growing demand for the company's products and is expected to bring about a considerable increase in productivity. The present level of employment at the works will be unaffected.

Most of the equipment now in operation was installed in the period 1931-1939, and the many subsequent developments both in the uses of aluminium and in manufacturing methods have made re-equipping essential. Details have been worked out by the company's engineering staff in collaboration with equipment manufacturers after studies lasting several months. Owing to the importance of maintaining full production the programme will be accomplished in a number of separate stages, the last of which is not scheduled for completion until 1958.

The modernized mills and melting room will incorporate the latest equipment designed to achieve high volume output, including a larger and more powerful hot mill capable of rolling ingots of over a ton in weight. Melting furnaces are being overhauled and modernized and improved re-heating equipment will also be built.

FROM MARCH 14 the offices of Jenolite, Limited, anti-corrosion specialists and manufacturers of industrial chemicals, will be at 13-17, Rathbone Street, London, W.1 (telephone: MUSeum 5411).

Shell-moulding of Non-ferrous Metals

ABBF Advisory Service Interim Report

A meeting of London-area copper-base founders organized by the Association of Bronze & Brass Founders, was held at the Clarendon Hotel, Hammersmith, London, on January 20, when Mr. J. L. Rice, a member of the liaison staff of the British Non-Ferrous Metals Research Association, gave a talk on "Shell Moulding." Mr. W. R. Buxton took the Chair.

THE CHAIRMAN welcomed Mr. Rayner, the president of the Association, and also all members and non-members, in particular Mr. Tatham, a visitor from Australia. The meeting was one of a series being sponsored by the ABBF and the BNFMRA, in connection with the Conditional Aid Advisory Service which was being run for the Board of Trade. As it was envisaged that everyone present would have a fair knowledge of the subject of shell moulding no attempt would be made to explain the process from its beginnings. Mr. Rice, a practical foundryman, had carried out a survey of the shell-moulding process for over three months, and the interim report on which his talk was based was the result of that three months' investigation into shell moulding from all its aspects —machines, methods and materials. Mr. Rice had been given a great deal of help from both makers of machines and makers of materials, and also in foundries which were using the process. The interim report had been issued by the ABBF and also by the British Non-Ferrous Metals Research Association and was available to ABBF members or non-members who wished to purchase it.

Reception of the Scheme

The Chairman then invited Mr. Cleaver, representing the ABBF, to indicate what progress the Advisory Service was making.

MR. CLEAVER said the Advisory Service was an endeavour to give assistance to bronze and brass founders who wished to increase their productivity; that hackneyed expression meant either to increase output or to lower costs, the latter possibly being more sensible. There had been about seventeen applications from foundries, for visits or advice from technicians, not all of which had come within the scope of the Service. There was a number of firms already who had received help and had agreed to pay the charges which had been levied, and so the scheme was operating.

One of the objects of the talk that evening was to encourage foundrymen to take an interest in shell moulding, and arrangements had been made with the BNFMRA whereby they would co-operate in giving help through the scheme. The committee running the scheme was taking a good deal of trouble over it and the Conditional Aid funds were being administered with as much economy as possible. It was encouraging that relationships with the BNFMRA were on a very good footing. Much interest all over the country was being taken in the subject of shell moulding, and it was hoped that Mr. Rice's talk and the subsequent discussion would assist foundrymen in the London area generally.

Introducing the speaker, the Chairman said Mr. Rice was a practical foundryman of many years' experience on the foundry floor, and he had entered upon his survey with an open and unbiased mind. Undoubtedly anything he had to say would be factual and practical.

Résumé of the Report

Mr. Rice then gave his talk on the shell-moulding process, in the course of which he outlined the types of shell-making machines now available and discussed the mixing process. It seemed here that while most foundries used existing equipment such as a roller mill or a rotary mixer, a better approach would be to consider the use of cube- or cone-shaped plant, designed for the mixing of dry powders.

The commonly used pattern materials were listed and details were given of their physical properties so far as these affected their use in shell moulding. Work by Mr. D. F. Bailey had shown that the contraction of the hot shell was similar to that of a steel pattern from which it was made. Since the contraction of aluminium was twice that of steel this appeared to explain the sticking which certain foundries had experienced with aluminium patterns. Anomalous contraction effects had also been met with, so that when absolute dimensional accuracy was required it was important that patterns should be so constructed that later adjustments could be made at low cost.

Details were given by Mr. Rice of some of the sands used in the shell-moulding process and desirable characteristics were listed. There was evidence that zircon sand gave an improved surface finish, together with some economy in resin, but its price was uneconomic unless some system of reclamation could be employed. He exhibited Table A as a slide, giving comparative costs of silica and zircon-sand mixes.

TABLE A.—*Comparative Costs of Silica and Zircon Mixes.*
One Unit { 100 lb. Silica mix (Redhill "H").
200 lb. Zircon mix.

Resin content (percentage of sand weight).	Percentage loss of sand per cycle.	Cost (pence).	
		Silica.	Zircon.
2	100	—	506
	10	—	166
	5	—	147
4	100	159	626
	10	131	293
	5	130	275
5	100	190	—
	10	163	—
	5	162	—

Based on Redhill "H" sand at £3 ton; zircon sand at £18 ton and resin 2s. 8d. lb.

Shell-moulding of Non-ferrous Metals

Gating Principles

Few principles seem to be in operation on the subject of gating and feeding, but the view had often been expressed that green-sand practice could not be adopted without modification. It might be, though, that the true position was that shell moulds were more sensitive to unsatisfactory gating methods than sand moulds and if this was the case, the practice of using reverse-taper sprues of large diameter (which would make the maintenance of a head of metal during pouring a virtual impossibility) was very much to be deprecated.

One authority had recommended tapering the sprue in the area ratio 4:1 and had recommended also that the runner should be greater in area than the sprue and the total ingate area at least equal to the runner area. Dross traps should be provided with high-drossing alloys. The Connor-block runner had also been used with some success.

The various methods of closing shells were outlined, and it was emphasised that no really satisfactory method of universal application existed. The characteristics which a system of closing should ideally possess were listed.

On the subject of dimensional accuracy, some firms were prepared to guarantee 0.005 in. per inch. on simple castings for dimensions which occurred in the same shell. The provision of further data based on the study of production batches would be very desirable.

The work of Ames, who had cast wedges in shell moulds both backed and unbacked and compared them with green-sand controls, was discussed, and it was shown that the shell castings had without exception a larger grain-size than the control. Comparison of the mechanical properties of castings made in backed shell moulds with a green-sand control showed that the shell castings had, if anything, superior properties. Data on castings from unbacked shells were not available.

The economics of the process were briefly discussed and the conclusion was reached that no accurate comparison with green-sand moulding was possible at the present time.

The future of the process was thought to depend very largely on the development of improved methods of closing and on methods of reducing the resin cost. Other possible developments of the process were touched upon and the other competitors of shell moulding in the field of precision casting were listed.

DISCUSSION

MR. TATHAM (H. Brehaut & Company, of Australia) asked what had so far been found to be the best method of reclamation of sand.

MR. RICE, in reply, said so far as he knew only one method of reclamation of sand had been used because it seemed to be reasonably satisfactory as far as one could tell at the moment. The broken "biscuit" was put into a form of incinerator, a gas torch was applied to the bottom of the incinerator and the biscuits were set alight, and once well alight they would continue to burn without any further application of external heat. If it were then so arranged that the sand from which the resin had been burnt could fall into a hopper, one had a relatively-efficient method of reclaiming sand at practically no cost. After all, the shell residues had to be dumped somewhere and one might just as well dump them into an incinerator and burn off the resin.

Relative Cost of Sands

MR. A. TALBOT (Western Foundries), referring to Table A, showing the costs of sands, said Mr. Rice had remarked that the costs of zircon and silica were comparative, but it seemed he had not taken into account the volume comparison. If one had 100 lb. of silica and got, say, ten biscuits, would one get ten out of the zircon? The industry was not worried about the cost of the sand, but about the cost of the biscuits: if the weight was greater the cost per pound did not bear much relationship to the cost of each biscuit. It would also be interesting to hear how Mr. Rice had arrived at the figure of about 166d. per 100 lb. of zircon sand, allowing 10 per cent. loss.

MR. J. L. RICE, in reply, said he had probably not made the point very clear that the figures in Table A were based (as explained in the title) on the equivalent shell-making capacity of the mix. In other words,to make the same number of shells one would need 200 lb. of zircon mix instead of 100 lb. of silica mix, and for about 166d. one would make exactly the same number of shells as for 163d. in the case of the silica mix, both assuming about 10 per cent. loss in the cycle.

MR. TALBOT said he had based his remarks on the 4 per cent. resin mix.

MR. RICE, in reply, said if one compared 2 per cent. resin in a zircon sand mix with 4 per cent. in the silica mix it did not look very attractive, but possibly a fairer comparison was 2 per cent. zircon and 5 per cent. silica, and if that operated then these figures were pretty well identical.

Controversial Points

MR. J. FALLOWS (Polygram Casting Company Limited) complimented Mr. Rice on the large volume of work which he had tackled in the three months' period available for the Report. There was, however, a real danger in the endeavour to cover too large a field in too short a time. There was a large number of statements in the Report which were not accurate and his organization would be submitting a communication with regard to those points. To mention but a few, there were four factual errors in the statements with regard to plant and equipment on the first unit and on the second unit there were five further errors, all of which would mislead people. Another point which stuck in his mind rather badly was the constant reference to American practice as being the only published knowledge and the statement that there was no knowledge available in this country. There were also quite a number of statements such as "Pressure-investment is just being explored." In point of fact the first mechanized plant produced in this

country was a pressure-investment machine. Also, with regard to the thickness of the glue between the joints upsetting the accuracy, anyone with any experience in shell moulding knew very well that the glued joint was actually less than one per cent. responsible for inaccuracy across the joint. Furthermore, people producing castings by the shell process nearly always refrained from quoting limits on a casting in those circumstances: they tried to keep close tolerances to one half of the mould or else severely left the job alone.

Zircon Sand

With regard to the cost of the zircon sand, the remarks on this subject indicated a distinct field which would merit really thorough investigation. His own experience with zircon was the very reverse of that quoted by Mr. Rice on the peel-back problem. He did not pretend to be able to explain why, but on a similar experimental job, peel-back was one of the troubles which completely disappeared, and an important factor which had been overlooked and on which zircon would assist was, of course, the refractory qualities of that material. No doubt Mr. Rice would agree, and had merely omitted to make mention of it.

Much information had been given to the foundry industry within this country by his own organization: his firm had had the representatives of over 400 foundries in their plant, discussing and debating such problems as had been mentioned, and a mass of information had been published with regard to costs. Data had been circularized of actual production experiences achieved.

Pressure Machines

MR. RICE, in reply, thanked Mr. Fallows for his contribution. He was certainly interested to learn that pressure was not such a new thing as he had been led to believe. He was, of course, aware that Polygram had taken a Patent out which involved the use of a machine which did in fact press the pattern into the sand. However, it was not quite clear from Mr. Fallows' remarks whether the pressure system of shell moulding was started and then abandoned or whether it was still regarded as having potentialities for the future. Possibly, Mr. Fallows could enlarge a little on that subject but he would probably agree that all the machines which were being marketed in this country at the present time did in fact, almost without exception, use a dump-box for investing the pattern.

The subject of glueing the shells presented a very vexed problem and although he agreed that there were a number of foundries which were in fact glueing their shells and claiming to be doing it satisfactorily; he could also instance a number of foundries which had found the method a little unreliable. It was difficult to understand why, if the glueing only had a one per cent. influence on the dimensional accuracy across the joint-line, a foundry should be so hesitant about quoting dimensional tolerances across that joint-line.

It was very interesting to hear of Mr. Fallow's experience with zircon, and the fact that peel-back did not seem to be a problem when zircon sand was used. It certainly made the use of zircon still more attractive because the question of peel-back was one factor when using zircon which had seemed to need a little investigation, possibly in co-operation with resin manufacturers. Improved refractoriness of zircon sand was indeed a factor to be taken into account, although he had not been under the impression that the industry was much concerned about poor refractory qualities of silica —certainly not in non-ferrous work.

Other Data

On the subject of costs, it would be very interesting if Mr. Fallows could in fact publish openly some of the comparative data, because many foundrymen would be interested to see such figures. It was obviously a matter which exercised some foundrymen's minds to the greatest possible extent when they came to consider whether or not to embark on shell moulding. Comparative data on jobs which had in fact been produced on a mechanized foundry plant of the normal type and which was then proposed for transfer to a mechanized shell-moulding plant would be very useful, but possibly misleading if compared with the cost of manufacturing the casting off a loose wooden pattern, because the two methods were not comparable.

MR. FALLOWS said Mr. Rice was in error with regard to the pressure. In his earlier remarks he had not been alluding to a patent of an original machine. Mr. Rice, in company with anyone else who wanted to, could visit his firm and see their rotary machine which used pressure investment.

With regard to glueing, the figure of one per cent. error across the joint was quite correct. However, if one wished to make a cylinder 5in. dia. in shells it would be found that the casting would be approximately $\frac{1}{4}$ in. out of round. The characteristics which created that problem had nothing at all to do with the fact that the joint was not closed. It was due to the fact that cooling of the metal was retarded around the joint line, due to the double thickness of shell at that point.

Another factor which had to be taken into consideration was the fact that the metal was trying to push the two halves apart: it did not succeed —one could take a casting from a shell mould without any flash whatever. With regard to the cooling characteristics, if the metal was not gated and fed correctly one would be in the same trouble, dimensionally.

With reference to published data on costs, anyone requiring a copy should write to him, when the documents would be sent by return of post.

Sand Reclamation

MR. ELLIOTT (B. Elliott & Company), referring to the reclamation of sand, asked whether such reclaimed material would have to be diluted with something else or mixed with fresh sand.

MR. RICE said that such information as was available—and there was still more work to be done on that subject—pointed to the fact that the

material could be used repeatedly in the same way as new sand and without additions of fresh sand, except, of course, in so far as one had to make up physical losses. Obviously what crossed one's mind in such a case was a possibility of build-up of fines in the mix which could lead to an increase in resin percentage being necessary. The evidence seemed to show, however, that such a build-up of fines was not a serious factor because the grain fragments were so fine that in the course of moving the sand around, one tended to lose them and the effective grading of the sand did not change very markedly. Provided the burning-out of the resin was reasonably efficient there seemed to be good grounds for believing that a satisfactory material could be obtained at the end of it.

Aluminium Patterns

MR. J. E. WORTHINGTON (Polygram Castings Company, Limited) said one should be very careful not to draw too many conclusions from what might be, at the moment, simplified figures presented in Mr. Rice's Interim Report. For example, linear expansion figures for patterns were shown, and deductions were made therefrom. However, the expansion of a pattern was a cubical expansion and one had to be very careful to make quite sure that it was assumed that a pattern contracted cubically in proportion to all contours of the pattern shape.

Many shell moulds had been made successfully from aluminium patterns. After all, the shell was ejected when the pattern was hot, and even if it did contract less than the aluminium pattern one would not perhaps get the dimensional accuracy but it was difficult to see how it could provide an answer to the fact that the moulds might stick to an aluminium patternplate. The same applied to the graphical curves exhibited in relation to the physical properties of shell-cast metals, which were only in fact single points. Everyone knew that with a series of test-bars the results would cover a range, and it was a fatal mistake to make assumptions of relative strengths on points determined from only one or two tests. Statistical evidence from a large number of tests was necessary before one could make any definite conclusions.

He was glad to see that Mr. Rice had included a sieve analysis of the recommended sands, because he did not think that the AFS grading was satisfactory: it was possible to get two completely different sieve gradings of sand having the same AFS number.

Mould Backing

With regard to the fact that we had not perhaps studied the packing of shells so much in this country, there was an essential difference between the foundry practice of this country and that of America: the latter had long runs; British practice was essentially on a jobbing basis and any method of closing the shells had to be as flexible as possible. He did not believe that in all cases backing of moulds particularly lent itself to the utmost flexibility.

Contraction and Test-bar Results

MR. RICE in the first place agreed that many satisfactory shell moulds were being made from aluminium patterns. The only point he had wanted to bring out in the figures quoted—and, of course, they were of linear coefficients of expansion, though he believed they were valid for all that—was that there was a difference in temperature between shell and pattern: there was a cooling down from when the pattern was in the oven, when it was being cured, and when it was being ejected, and some difference in temperature between the shell in the oven and at the time of ejection. If, under such circumstances the amounts of contraction differed, then for a pattern contour in aluminium that had two flanges, say, projecting from the plate, that might very well be a source of shells sticking. That, he believed to be a reasonable argument and one which was to a certain extent borne out in practice.

Turning to the test-bar figures, he had no detailed information on how many results each of those points in fact represented, so he was not able to speak on that subject. He would agree, of course, with Mr. Worthington that one result was a very doubtful figure upon which to base any sweeping conclusions. All he had been seeking to demonstrate when the slides were shown was that there seemed to be no grounds for concluding that a shell-moulded casting was inferior to those cast by other methods.

He agreed with Mr. Worthington on the subject of the AFS grading figures; they were indeed a very rough guide, and could often be misleading. Possibly their only use was that with one sand having a grading of 150 and another one of 90 was an indication that the 90 grade was coarser than the 150, but grading figures of 150 to 130 probably did not mean anything.

He had been a little surprised to hear Mr. Worthington say he did not regard backing of shells as a flexible method, as personally he would have thought that that was one of its advantages. Surely, the main disadvantage was that it would be such a clumsy method unless one really set out to deal with it as a fully-mechanized operation?

MR. WORTHINGTON said it really depended upon the meaning one attached to the word "flexible." In the foundry, the introduction of large amounts of any material into a process tended to make it more inflexible. Backing of shells introduced large masses of sand into shell-moulding, and surely once one did that one had a less flexible method.

To Back or Not to Back

MR. RICE replied that in his view the essential qualities needed in any backing system were that it would cope with a wide variety of shell sizes and different types of castings. If one had a mechanized system for introducing backing material, be it sand, gravel or shot, and at the knock-out one

extracted that material and returned it to its original point, it would be possible to cope with a wide range of shell sizes. This feature seemed to be an essential quality needed in the packing or closing operation for shells, provided the other characteristics such as holding the shells without movement or distortion, or if the metallurgical properties were not adversely affected.

MR. FALLOWS said it was a very contentious point. Surely it was not possible for a method to be both clumsy and flexible? Over a wide range of shells one was dealing with pressure heads of anything from ¼ up to 6 tons, and therefore the backing shot should be so placed that there was more presure on the outside from sheer weight of packing to offset the pressure head in the mould. He could vouch for it that for two whole years his firm had tried nothing else but backing, and there was more flash and more scrap.

In the case of the Ford Motor Company's production of crankshafts by tens of thousands at a given point, a given amount of shot round that mould would well and truly pack it and the method was excellent, but if one wanted to turn out a crankshaft on one occasion and a valve-seat the next time one would have to keep varying the volume of material around the shell and that would be completely impossible in a jobbing foundry.

MR. RICE, in reply, said he was interested in the experience of Mr. Fallows and quite clearly he was unable to argue with him on that point. However, when he had said the method was clumsy the inference was that it was clumsy unless one set out to deal with it properly. Obviously if one tried to pack in a hand-to-mouth fashion, by shovelling in sand or shot, the method was clumsy but if it was treated as a mechanical-handling problem then it did not become clumsy.

It was important that Mr. Fallows had found the metal pressure head was such a variable that backing of shells was not a satisfactory method, and he would be very pleased inded if Mr. Fallows would publish details of the work done in order that others might avoid falling into the pitfalls which apparently awaited them.

MR. FALLOWS said he had published the information in a paper to the Institute of British Foundrymen.

Out-of-Roundness

MR. JONES said he was not a foundryman but a prospective customer, so that he trembled a little at addressing the meeting, but he was very interested in the point of glueing or not of the "biscuits," because he needed castings that were round and consistent. Shell-moulded castings had been submitted to him which were required to be round and yet they were out of round by between 0.0020 and 0.0025 in. He had got in touch with the people concerned and asked if he could send one of his planning engineers to the foundry because he felt in his ignorance that the glue between the shells was not holding, the "biscuit" was spreading under the pressure and he was getting a bad casting as the result. The planning engineer had visited the foundry with instructions to ask for some holes to be drilled through the shells close to the casting and some bolts to be put through to hold them together. Two shells were treated in that way and the resulting castings were round, to within 0.0005 to 0.0007 in.—so he had then asked the firm to make them all like that. Of course, the question of price arose, because such procedure would cost more. Thereupon he had pointed out that it would mean even more money for him if he did not have the castings round, and that was how he wanted them. However, he did not get them like his samples, even afterwards he got them 0.0040 in. out of roundness. If foundrymen could find a way of giving him round castings, whether they stuck the shells together or whatever means they adopted, he did not care—he wanted them round!

MR. RICE said he did not feel it was a matter which required any answer from him; there were many foundrymen present, to whom he would be pleased to leave the floor.

MR. FALLOWS recommended Mr. Jones to keep the impression within one half of the mould if he really insisted on his castings being round!

Pattern Cement

MR. TALBOT asked whether Mr. Rice had any experience of patterns made in pattern cement, and whether it functioned for short runs?

MR. RICE said he had not come across anyone using that material for patterns and he did not think it was likely to be very successful because of its characteristic behaviour when heated. It would probably be possible to make a shell from such a pattern but it would take a very long time to do it; one might have to invest for a matter of minutes at least.

MR. WIDMER (J. Stone & Company (Charlton), Limited) said he could answer that question to a certain extent because he had done a little work on the subject. As far as he could see, none of the pattern cements would stand up to thermal shock. However slowly one heated them, they would ultimately crack up.

MR. A. R. PARKES said he wished personally to congratulate Mr. Rice on producing such a fine report in a very short time, and to ask him to carry on with the good work. Shell moulding was a promising field which, despite the great amount of work which had already been done, was still open. For instance, Mr. Rice had mentioned that most of the work was being done with phenol-formaldehyde resins but there was also a vast field of other resins which could be explored—there was one around the corner, perhaps, which was the answer for which everyone was looking. He had seen urea-formaldehyde resins used for steel castings 3-in. thick and u.f. resins were two-thirds of the price of p.f., if not less. There were even such things as cold-setting resins.

THE CHAIRMAN pointed out that the Report was only an interim one and that further work was being done, of which he hoped investigations to do with resins would form a part.

Shell-moulding of Non-ferrous Metals

Mould Ejection

MR. WIDMER said it appeared that the economics of shell moulding were rather tied up with the method of ejection of the biscuit, to a certain extent. The pin ejector normally adopted took up a considerable area of the patternplate, whereas shock ejection obviated the pins. He could quote instances where, by the normal method a patternplate had only been capable of taking eight small patterns whereas with shock ejection twelve could be accommodated. With regard to the casting of cylinders, and so on, the properties of the resin selected definitely were most important—plasticity at working temperatures varied from one resin to another.

MR. RICE agreed that very often the use of the spring-loaded ejector pins did hamper one in the number of patterns which could be put on a plate, but he was not very familiar with shock ejection and so did not feel able to comment on that at all usefully.

On the question of resin composition, plasticity at high temperature was a very interesting problem and one on which extra data would be welcomed. He would be interested to have a contribution from anyone who felt able to offer it on how far such hot plasticity was in fact necessary and how far it could be eliminated. Quite clearly such a property of the resin played an important part in dimensional accuracy and there was still a very large field for work which must be done by the resin manufacturers themselves. The sooner one could put a limit on hot plasticity, the better off founders would be as regards getting shell moulded castings of high accuracy.

Future Research

MR. CABLE (British Resin Products) gave his assurance that the resin manufacturers were all working very hard, not only to reduce the price of resins for shell moulding but also to improve the hot strength and to cut out the plasticity which was apparent in some of the resins. It was not an easy job, but at least the resin manufacturers would take that load off Mr. Rice's shoulders.

THE CHAIRMAN asked when he could look forward to seeing the results of tests on improved physical properties, such as Mr. Rice had said would be pursued.

MR. RICE, in reply, said he did not want to mislead the meeting on that point. He had not said that the work was being done but had stressed the desirability that it should be done. He believed himself that it was work that the BNFMRA could properly do and which in the end they might decide to do, but at the moment he was unable to say more than that. The present lack of reliable data certainly stressed the importance of figures of that sort.

THE CHAIRMAN said he regarded that aspect as rather an important point in following up Mr. Frank Hudson's ideas on securing improved physical characteristics from cast metals, thus enabling one to reduce the size of castings, and so on. It was to be hoped that something would come of it.

Shell-moulding Sand

MR. ELLIOTT said some two or three years ago he had attended a lecture on shell moulding when the people who supplied the sand were talking about getting to the end of their quarries and being unlikely to supply any more. Was that likely to be the position within a short time?

MR. LOVATT (British Industrial Sands, Limited) said there were very large resources of shell-moulding sand in this country although some of them were rather difficult to get at and were in that condition where to work them on the scale they were at present required would be very uneconomical. Like the foundrymen, the sand producer had to live—to run a sand quarry economically one had to turn out pretty large quantities. As an instance, from his firm's two large quarries the total production in one week was something between 10½ and 11½ thousand tons of sand of all types; of that the total production of shell-moulding sand was about 150 to 160 tons—and yet they were sending that shell moulding sand all over the country. So it would be seen that although the demand had risen quite sharply in the last few years (and particularly in the last few weeks), the total requirement still represented a mere flea-bite in the amount of sand throughput needed to run a quarry economically. Obviously, the greater the demand for shell-moulding sand, the easier it became to work, so that although he could give his assurance that taking the long term view there was no shortage of suitable sand for shell moulding, there certainly would be temporary shortages. Quite frankly, customers for ordinary sand had subsidized the extraction of shell-moulding sand to the extent at one time of about 90 per cent. The cost of producing shell-moulding sand in the very small quantities in which they were first bought—amounts between £5- and £10-worth per week—was carried by the other customers and not by what the foundrymen thought was the exhorbitant price they were being charged for the sand itself.

Availability of Zircon Sands

THE CHAIRMAN asked whether anyone present had any figures on zircon sand that could be put forward as an answer to the sand question. Presumably there was no shortage of zircon, which came from Australia.

MR. LOVATT said the Australian zircon deposits were very large indeed and would be sufficient to swallow the requirements of the shell-moulding process without effort. Prices for that material in this country ranged from £18 to £25 a ton. Demand, of course, would reduce those prices a little, but one had to take into account the fact that the major part of that amount was taken up in freight charges, and one might not get as big a reduction as expected. Actually, in the case of some Redhill sand which his firm had sent to New Zealand last year, the delivered price in New Zealand was £21 per ton, so it was very comparable with zircon sand being sent over here.

(Continued at the foot of page 266)

Iron Castings Output and Pig-iron Supplies

Last Year's Figures in Relation to Pig-iron Capacity

EXPANSION IN IRONFOUNDING

Total Output

The United Kingdom output of iron castings in 1954 was 3,742,000 tons, 2.9 per cent. more than in 1953, and almost as high as the record outputs achieved by the industry in 1951 and 1952. The overall level of activity was fairly steady for most of the year, after allowing for normal seasonal influences, but there was considerable expansion during the last quarter. All the indications are that this higher tempo of production is being maintained into 1955, and if this continues, new records will be broken this year. For some sections of the ironfounding industry, this stage was already reached during 1954.

Automobile Castings

This section has produced a record tonnage in keeping pace with the higher production of motor vehicles and tractors. Iron castings to the motor industry include such essential components as cylinder blocks and brake drums. The output of iron castings for cars, commercial vehicles, cycles and motor cycles was 316,000 tons, 16½ per cent. more than in 1953. Agricultural-implement and machinery castings (mostly for tractors) were 183,000 tons, 27½ per cent. more than in 1953. There is every indication that the automobile section will achieve an even higher output in 1955.

Main Sectional Divisions

Table I shows the output of iron castings (grey and malleable) in 1953 and 1954, for each of the six main sections of the ironfounding industry.

TABLE I.—*Iron Castings Output in 1954, by Sections.*

Section.	Tons (nearest 000)		Percentage change 1953/54.
	1953.	1954.	
Automobile (excluding tractor) ..	271,000	316,000	+16.5
Pressure pipes and malleable-tube fittings	683,000	711,000	+ 4.0
Engineering and jobbing ..	1,432,000	1,486,000	+ 3.8
Building and domestic	549,000	566,000	+ 3.3
Railway equipment	329,000	311,000	− 5.3
Ingot moulds	374,000	352,000	− 6.0
Total	3,638,000	3,742,000	+ 2.9

Apart from the outstanding increase in the production of automobile castings, most other sections showed smaller increases. Two sections, ingot moulds (mostly used in steel production) and railway castings, had a slightly lower output than in 1953.

Within these broad sections, individual items showed much larger increases, as is shown in Table II.

District Production.

Of the 22 ironfounding districts in the UK, 14 had a higher output in 1954 than in 1953. The West Midland counties, which are a major centre of the ironfounding industry, increased output by nearly 10 per cent. over 1953. Several of the smaller producing districts also had excellent increases (Table III).

TABLE II.—*Percentage Increases for Various Types of Castings.*

Iron castings for:—	Percentage increase 1953-54 (by weight of castings).
Baths and cisterns, etc.	+22.7
Stoves, grates, etc. (gas)	+15.8
Stoves, grates, etc. (elec) (a relatively small item)	+62.5
Printing and paper machinery ..	+13.0
Textile machinery	+10.8

TABLE III.—*Increases in Iron Castings Production, by District.*

District.	1954 output. (tons).	Percentage Increase over 1953.
Shropshire, Staffs., Worcs., and Warwickshire	715,200	+ 9.9
S. Wales, Herefordshire, and Gloucestershire ..	205,100	+ 5.2
Essex and Kent	131,100	+25.3
Somerset, Dorset, Wilts., Hants. and Sussex	56,100	+ 5.6
Middx., Surrey, Herts., and Bucks	53,800	+ 9.0
Leics., Northants., Hunts., and Rutland ..	49,300	+11.1
Suffolk	36,600	+ 7.9

The largest falls in output were recorded in Scotland and Cheshire.

Raw Materials.

The ironfounding industry's consumption of its principal raw materials, pig-iron and scrap, is shown in Table IV.

TABLE IV.—*Pig-iron and Scrap Consumption by Foundries.*

	Tons.		Percentage Increase 1953-54.
	1953.	1954.	
Pig-iron (including refined iron)	2,337,000	2,357,000	+ 0.9
Iron and Steel scrap (about half is foundry circulating scrap) ..	2,786,000	2,963,000	+ 6.3

Labour.

The ironfounding labour force increased from 141,220 to 142,751 persons during 1954. During the last five months of the year there was a 3 per cent. increase, half of which was in the Midland region. A few regions had their labour force reduced slightly during 1954, notably Scotland and the Northern region of England.

PIG-IRON PRODUCTION

Plans of the Iron and Steel Board for further expansion of the iron and steel industry were set out in a report* published recently. The appended extracts from this report give details of provisions for increasing pig-iron production.

A major feature of development in the period to 1958 will be a large expansion in the production of pig-iron. Table V shows the output of pig-iron in the various districts in 1953 and 1954, with an estimate for 1958, and Table VI lists the major schemes now in hand.

* "Development of the Iron and Steel Industry ,1953 to 1958," published by HMSO (1s. 9d.).

TABLE V.—*Pig-iron Output.* (*Thousand Tons.*)

District.	Actual.		Potential 1958.
	1953.	1954.	
Northamptonshire, etc. ..	2,207	2,275	2,450
Lancashire, etc.	618	709	1,375
Yorkshire			
Lincolnshire	1,559	1,647	2,000
North-East Coast	2,646	2,811	3,650
Scotland	863	947	1,200
Staffordshire, etc.	474	482	550
South Wales	1,652	1,894	2,600
Sheffield	166	164	175
North-West Coast	930	954	1,150
TOTAL	11,175	11,883	15,150

Rapid progress has been and is being made in the modernization of furnaces for basic pig-iron.

TABLE VI.—*Principal Pig-iron Development Projects.* (*Thousand Tons.*)

Company.	Production.		Increase, 1953 to 1958.	Potential output, 1958.
	1953.	1954.		
Lancashire Steel	255	250	195	450
John Summers (Shotton)	265	380	615	880
Appleby-Frodingham ..	970	1,040	330	1,300
Richard Thomas & Baldwins	210	230	130	340
Consett	530	615	170	700
Dorman Long	1,205	1,280	495	1,700
South Durham	475	480	325	800
Colvilles Group	690	750	310	1,000
Steel Company of Wales ..	700	915	750	1,450
Richard Thomas & Baldwins	345	365	205	550
Barrow Ironworks ..	260	270	190	450
TOTALS OF ABOVE ..	5,905	6,575	3,715	9,620
Others	5,270	5,308	260	5,530
GRAND TOTALS (Table V)	11,175	11,883	3,975	15,150

The average output per furnace is increasing substantially. Most of the additional output of basic iron is being obtained from new furnaces which will reach or exceed the standard set in the Productivity Team Report of 1952 (27-ft. hearths for furnaces using home ore, and 25-ft. hearths for those using imported ore). Where new furnaces of smaller size have been built, they have been required to balance up production. At the same time, important increases in the output from many furnaces have been achieved by improvements in the preparation of materials, and in particular the crushing, screening and sintering of iron ore. The increasing proportion of imported ore used is also an important factor.

Foundry Iron Under Consideration

The main improvement in blast-furnace efficiency has been in furnaces serving steelworks, where there has been a big programme of expansion as well as modernization. There has been less modernization of the hematite and foundry-iron furnaces, and it is necessary to consider how far present facilities are satisfactory. In this field discussions with the users have suggested that the requirements for low-phosphorus foundry iron, which is particularly needed for automobile and other engineering castings, will increase in relation to the requirements for hematite and high-phosphorus iron. The adjustment of output to meet this demand, as well as the provision of more efficient plant for the production of foundry and hematite iron generally, is under discussion.

Shell-moulding of Non-ferrous Metals

(*Continued from page 264*)

Vote of Thanks

THE CHAIRMAN proposed a very hearty vote of thanks to Mr. Rice for his talk and for answering the questions—a proposition which was carried with acclamation.

THE CHAIRMAN, before closing the meeting, said that quarterly gatherings were being held in the area open for all founders, irrespective of whether or not they were members of the ABBF, and he wished to get the feeling of the present assembly on what other subjects might be discussed, particularly at the meeting to be held on April 19, and also whether future meetings should be in the evening or in the afternoon, following luncheon. The question of melting furnaces had been suggested as a possible topic.

MR. FRENCH suggested the CO_2 process as a desirable subject.

On a show of hands it was decided that the meetings were best held in the evening.

MR. A. F. RAYNER (president of the ABBF), said the Association was very much indebted to Mr. Buxton for the energy that he had shown in the preparation of the meeting and he would like everyone to give the chairman a little encouragement in the usual manner.

Staveley Coal & Iron Changes

Chairman of the Staveley Coal & Iron Company, Limited, since 1951, Mr. Thomas Aloysius McKenna is concentrating his activities in that position and has resigned as joint managing director. Col. John P. Hunt, who previously shared the position with him, has become sole managing director. Mr. McKenna joined the company over 30 years ago as London manager and became commercial manager in 1939; he joined the board in 1944 and was appointed deputy managing director two years later.

A wide section of the coal, iron and chemical industries has been embraced by Mr. McKenna's career. A year ago he gave up the chairmanship of Staveley Iron & Chemical Company, Limited, following Staveley Coal & Iron's decision not to negotiate with the Iron and Steel Holding and Realization Agency for the purchase of the company. Colliery concerns figure among his other business interests. In recognition of his prominence in the chemical world, Sheffield University awarded Mr. McKenna the honorary degree of Doctor of Laws at a congregation when the new chemistry building was opened last year.

Col. Hunt was Master Cutler in 1949 and is chairman of the National Association for Rolled and Re-rolled Steel Products. He is well known in Sheffield as managing director of the Hallamshire Steel & File Company, Limited, and a former Parliamentary candidate. Mr. M. Froggatt, who became a director of Staveley Coal & Iron last April, has resigned as secretary to become Col. Hunt's deputy. He in turn is succeeded by Mr. H. M. Earnshaw, assistant secretary.

Nodular Cast Iron*

Present Position and Future Prospects as an Engineering Material, with Special Reference to Suitability for Crankshafts

London Discussion of the Paper by S. B. Bailey, M.Sc. (Eng.), M.I.Mech.E.†

[SLIGHTLY ABRIDGED]

(*Continued from page 230*)

Continuing the record of this discussion, the written comments of Mr. V. H. Adamson, A.M.I.Mech.E.; Mr. R. J. Brown, A.M.I.Mech.E.; Mr. A. R. Kennedy; Mr. J. P. Quayle, B.Sc., A.M.I.Mech.E.; Mr. T. R. Twigger, A.M.I.Mech.E. (British Piston Ring Company, Limited), and Dr. A. H. Willis, B.Sc., Wh.Sc., are published in this issue. These concern cost and service comparisons between s.-g., iron and forged-steel Diesel crankshafts; machining difficulties; wear resistance related to structure and heat-treatment; availability of mischmetall; section sensitivity, and application of s.-g., iron to ploughshares. In a subsequent issue of the JOURNAL, the Author's replies will be published.

WRITTEN COMMUNICATIONS

Diesel Engine Crankshafts

MR. V. H. ADAMSON, A.M.I.Mech.E., wrote that the Paper contained details of a 6-b.h.p. Diesel-engine crankshaft in nodular cast iron which had been used by his company. The following was a brief history of the use of that particular crankshaft, together with a cost comparison between the part made in nodular cast iron and in the usual drop-forged steel.

Early in 1951, when it was becoming increasingly difficult to obtain suitable steel for the drop stampings for that crankshaft, a suitable alternative had to be found so that production remained unaffected. It was therefore decided to try experimentally a number of crankshafts made in the relatively new material of nodular cast iron. Sample castings were obtained of a crankshaft suitable for a twin-cylinder engine. That shaft was exactly as illustrated in the Paper (Fig. 22) except that there were two crankshaft throws. The early castings which were obtained were unsuitable owing to casting flaws, but one was finally machined and fitted to an engine. That engine was run for a short period and the crankshaft appeared to be quite satisfactory. During handling, however, the flywheel end of the crankshaft was accidentally given a sharp blow causing a fracture of the shaft between the flywheel and the adjacent main bearing. Examination of the fracture showed that the casting was unsound at that point.

A second shaft was obtained and fitted in the engine, and a further running test was undertaken. The engine was run for a total of 142 hours non-stop when the crankshaft was removed and examined. The examination revealed nothing out of the ordinary, and it was concluded that the shaft was satisfactory for further testing. The engine was re-built and run for well over 1,000 hours under various load conditions.

After that initial testing period it was decided to obtain some further sample crankshafts in nodular cast iron for the single-cylinder engine. At that stage it was decided that the rough castings should be subjected to a proof-loading test so that unsound castings could be discovered before any machining was done. The unmachined crankshafts were loaded as simply supported beams, as shown in Fig. D. The load of 7 tons was purely an arbitrary figure, being 50 per cent. of the actual breaking load of the crankshaft when loaded in that manner. The maximum stress obtained occurred in the crank web and was approximately 22 tons per sq. in., which was well above the maximum stress under working conditions. It ought to be mentioned that those crankshafts were supplied at that stage in the as-cast condition, and were specified to have a minimum ultimate tensile strength of 35 tons per sq. in.

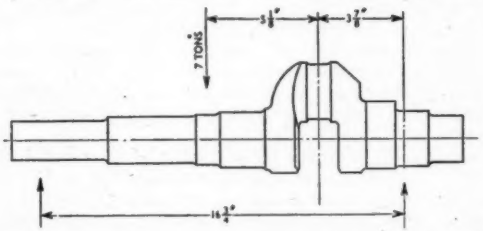


FIG. D.—*Loading test on unmachined crankshafts.*

Proof Loading

Breakages due to proof loading were as high as 50 per cent. of the total tested. At first that extremely high figure was thought to be due to faulty castings, but it was later considered that it was due

* Paper presented to the Institution of Mechanical Engineers and printed in the JOURNAL, May 20, 27 and June 3, 1954. Permission from the Institution to print the discussion is gratefully acknowledged.

† The Author is on the staff of Intelligence Division, London Headquarters, Department of Scientific and Industrial Research.

Nodular Cast Iron—Discussion

largely to the brittleness of the material. Castings were then obtained which had been subcritically annealed for 3 hours at 700 deg. C. Of these annealed shafts 90 per cent. passed the proof testing stage and, although the results were fairly consistent, it was considered that a more ductile material would be an advantage. Further sample castings were obtained with a heat-treatment of 2 hours at 900 deg. C., oil quenched, and tempered for 4 hours at 600 deg. C., air cooled.

That heat-treatment was finally used as standard on all production crankshafts, and breakages of approximately 1½ per cent. had been recorded on all the shafts tested.

About 16,000 single-cylinder engines had been fitted with nodular-iron crankshafts, and there was no record of any failure. The crankshafts under working conditions with the engines on full load had a stress range of from approximately 5 tons per sq. in. to an extremely small stress in the opposite direction, with a maximum full load speed of 1,800 r.p.m. The maximum bearing pressure on the crankshafts was in the region of 2,700 lb. per sq. in. Those nodular-iron crankshafts were made strictly interchangeable with the steel counterpart, and were, in fact, made to the same dimensions. It could, therefore, fairly be said that the nodular iron was, from a technical point of view, equally as good as steel for that particular application.

The Author had expressed his opinion that high surface-hardness was desirable on crankshaft journals and pins when copper-lead bearings were used. That might be true for steel shafts, but for cast-iron shafts the actual surface hardness seemed to have little influence on the rate of wear.

Machining Difficulties

On the question of production costs a very different picture was presented as, without any question whatsoever, his experience had been that the nodular-iron shafts were considerably more expensive to produce.

Owing to the high production rate required and the limitations of the machine capacity, the nodular-iron shafts had to be machined at the same rates as their steel counterparts, in order that the full production programme might be met. That resulted in exceedingly high tool consumption with resultant greater time spent in setting, and somewhat higher machine scrap. For example, with relatively fast machining—which was feasible with the steel counterpart—it was never possible to produce more than 17 crankshafts per tool re-grind on the turning operation. Furthermore, after that small number of shafts had been produced the face of the carbide-tipped tools was so badly worn that very frequently they were unsuitable for further use, and at the most, only three re-grinds were possible. Certain of the carbide-tool manufacturers had been consulted on that point, and had been given a completely free hand, but they had been unable to put forward a tool which could stand up to the high speeds and feeds involved.

The alternative to that high rate of tool consumption was to slow down operations to conventional cast-iron standards. That would, of course, immediately increase the cost of production, but in that particular case, it was impossible owing to the necessity of producing sufficient shafts to meet production demands from the available machine-tool capacity.

The total material scrap, plus machine scrap, was considerably higher on the nodular-iron shafts; that was illustrated in Table IX where the quanti-

TABLE IX.—*Scrap Details for Nodular-iron and Steel Crankshafts.*

Item.	Nodular iron.		Steel.	
	Quantity. units.	Per cent.	Quantity. units.	Per cent.
Quantity issued to machine shops	17,400	100	15,592	100
Material scrap	1,267	7.26	265	1.70
Machine scrap	319	1.84	176	1.13
Total scrap	1,586	9.10	441	2.83

ties shown for nodular iron represented the total used, whereas the quantities for the steel shaft showed comparable figures for production during the same period.

So far as material scrap was concerned, faulty material was normally returned to the manufacturer for either replacement or credit. The main point about that, however, was that faulty material on the cast shafts was not normally discovered until after finish-grinding of the journals and crankpins, when either porosity or blow holes would be revealed. Therefore, in most instances, all those scrap shafts had already been fully machined, and that was reflected in the final unit cost of the crankshaft.

TABLE X.—*Production Cost Comparison. (Non-dimensional Units.)*

Item.	Nodular iron.	Steel.
Material	109	100
Labour plus overheads	70.75	67.75
Machine setting	8.45	3.15
Consumable tools	24.6	9.53
Scrap	21.2	5.1
Total cost	234.00	185.53

Table X showed the overall cost comparison between steel and nodular-iron finished crankshafts. The figures shown in Table X were non-dimensional units in strict proportion to one another. That method of making the cost comparison had been chosen because actual cost figures could be very misleading. They depended largely on the method of cost accounting employed. Furthermore, since those cost figures were compiled both labour and material costs had changed. It was evident that in any of the cost divisions the production costs were higher for the nodular iron, the final cost per unit for nodular iron being some 26 per cent. higher than the steel stamping.

It was doubtful whether any worth-while saving would be made by increasing machining times since, even if the setting, tool, and scrap costs were reduced to the level of the steel component, the resultant

higher labour costs would tend to maintain the balance.

The employment of the shell-moulding technique had been suggested as a means of reducing the cost of cast-iron components. That might be correct for certain types of casting. The chief advantage in shell moulding was that a cleaner and more accurate casting was made, but unless it was possible to dispense with a machining operation, that was not necessarily reflected in reduced cost. It would appear, therefore, that for small crankshafts it would be unwise to draw any conclusions on cost reduction until comparable cost figures were available.

Wear Resistance

Mr. R. J. BROWN, A.M.I.Mech.E., wrote that the Paper comprised a valuable collection of published data: the Author's conclusions were quite fair in view of the information available to him, although there was undoubtedly a mass of unpublished data not generally available which might have caused him to modify certain observations. The greatest deterrent to the wider use of nodular cast iron was its high relative price, as stated by the author, but to that fact should be related the present patent position.

Insufficient reference was made to the relative machinability and resistance to wear of nodular cast iron in both the as-cast and heat-treated conditions and to the same properties of competitive materials: it was unfortunate that the cast material, possessing excellent wear resistance, was incapable of being machined at satisfactory speeds, whereas the annealed material, which could be readily machined, possessed extremely poor wear resistanee. A rig test carried out some time previously had shown the wear resistance of the annealed material to be similar to that of manganese bronze in the application in question, whereas a 17-ton flake-graphite iron showed twice the resistance to wear.

A laboratory test comparing nodular cast iron with competitive materials showed the rating, in order of wear resistance, given in Table XI.

TABLE XI.—*Rating in Order of Wear Resistance.*

Dry.	Lubricated.
Nodular cast iron, as-cast	14-ton flake-graphite iron
Pearlitic malleable iron	Die-cast iron, annealed
14-ton flake-graphite iron	Nodular cast iron, as-cast
Die-cast iron, annealed	Pearlitic malleable iron
Nodular cast iron, annealed	Nodular cast iron, annealed

The Author had not mentioned the possible application of nodular cast iron for the manufacture of brake drums. That application had been considered in the laboratories of his company some time previously, and thermal checking tests had shown the rating of appropriate materials to be as in Table XII in order of merit.

TABLE XII.—*Rating According to Thermal Checking Tests. Order of Merit :—*

1. Nodular cast iron, annealed.
2. 14-ton flake-graphite iron.
3. Pearlitic malleable iron.
4. Nodular cast iron, as-cast.
5. Die-cast iron, annealed.

It would be seen from that rating that the material most resistant to thermal checking was the annealed nodular cast iron; which was unsuitable owing to low wear-resistance, the conventional flake-graphite iron being the best all-round material.

Considerable scatter was shown in Fig. 12 for the notched fatigue results for wrought steel. That was not unusual, but what was most abnormal was the inference that the cast materials had notched fatigue properties which were consistently proportional to ultimate tensile strength.

Surface Hardening

Surface hardening was referred to as a means for increasing bending fatigue strength, and it could certainly be assumed that such treatment would increase the notch sensitivity of the hard surface layer, that being a normal phenomenon of the higher strength materials. In the application of such treatment, it was most necessary to pay attention to the pattern of the hardened zone, as should that terminate at a highly stressed location, the tension stresses in that zone which counteracted the compression stresses in the hardened layer, would promote failure by fatigue.

In the examples illustrated, surface hardening had been applied only to as-cast material, for full hardening that was essential, as the relatively short time of heating would not be sufficient for adequate solution of the precipitated graphite in the annealed material. Micrographs of the relative structures of as-cast and annealed material, surface-hardened by the high-frequency induction method under identical conditions had shown that the cast material developed a hardness of 58 Rockwell "C," whereas the annealed material developed a hardness of only 45 Rockwell "C."

In the discussion, a plea had been made by one speaker that the new material should be referred to as spheroidal-graphite iron: nodular cast iron was the term applied to the material by its originators, the British Cast Iron Research Association, and it would be a great pity for acknowledgment of its British origin to be lost by the adoption of the American term.

Cost of Mischmetall

Mr. A. R. KENNEDY wrote that the additional capacity for producing mischmetall which the Author had forecast as being required (some 20 tons annually) could be met far in advance of the seven-year period cited and, in fact, his company would be prepared to develop that in a period of twelve months.

It was most relevant to the Author's argument in regard to the production costs of nodular cast iron to note that the position had already been reached when it was possible to reduce the cost of mischmetall to some 24s. 0d. per lb. where substantial quantities were involved. The consequent saving on the magnesium/cerium process of 6s. 6d. per ton brought the total cost down to £18 7s. 6d. per ton, which, however, in the light of the Author's general comments, he was disposed to regard as still being tentative. He meant to imply that his company as manufacturers of mischmetall was prepared to make considerable further efforts to collaborate in

Nodular Cast Iron—Discussion

the development and adoption of the nodular-cast-iron process so that no intending manufacturer of nodular cast iron would need to be deterred by the cost of initial experimentation.

Mr. J. P. QUAYLE, B.Sc., A.M.I.Mech.E., A.M.I.E.E., wrote that in common with most engineers engaged in design he welcomed a Paper giving further details of a new material. The general title " Nodular Cast Iron " rather than the special aspect of the Paper prompted his questions and comments.

A slide had been shown illustrating a water-turbine volute, in grey cast iron as formerly, and in nodular cast iron as for present and future. The mean section in grey cast iron was 45 mm. and in nodular cast iron 25 mm. The mean thickness of the casting often bore little relation to mechanical considerations, and was largely decided by the requirements of the foundry, where uniformity of section was one prerequisite of good results. He asked whether the use of nodular cast iron permitted any relaxation of the stringent limitations imposed on designers in regard to sudden " changes in section " without prejudice to the production of sound castings.

Design engineers were always on the lookout for new materials, but although there appeared to be a range of possible uses, the controlling factor at present was the limited information available, particularly in regard to properties at elevated temperatures.

An axial-flow compressor casing which had been illustrated was promising, but further information would have to be provided before the designer could be encouraged to give the material a fair chance to " show its paces " under service conditions.

Wear Characteristics

Mr. T. R. TWIGGER, A.M.I.Mech.E., said that before asking a question of Mr. Bailey, he would like to comment on the really notable achievement of producing cast iron with the graphite in spheroidal form, thereby greatly enhancing the strength of the material direct from the casting instead of achieving it, as with malleable cast iron, by a very lengthy annealing process. That was not in the nature of a routine improvement, it was a process which involved an entirely new metallurgical concept. Such new and striking developments were met with but seldom during an ordinary working life.

It might easily be true that, for many purposes, the properties associated with either steel or malleable cast iron would be necessary, but there was, none the less, a wide scope for the new material, especially in the annealed condition, by which means exceptional ductility was achieved.

The particular point he wanted to ask the Author was whether any information was available on the wearing characteristics of spheroidal-graphite irons, as compared with conventional flake-graphite materials. The annealed type of nodular cast iron, used for its high strength with high ductility, would not, of course, be expected to show high wear-resistance, but the unannealed types, although having a pearlitic matrix, might find their applications limited if the change from flake- to spheroidal-type graphite seriously impaired the wear-resistance.

Ploughshares

Dr. A. H. WILLIS, B.Sc.(Eng.), Wh.Sc., A.M.I.Mech.E., wrote that the Author's reference to the use of nodular cast iron for ploughshares was noteworthy; in his own view, the whole range of tillage shares should be reviewed now that there was a material with a hard wear-resistant surface capable of being cast in thin sections and having reasonable impact-resistance.

In many arable areas of Australia, the mouldboard plough was being replaced by a cultivating type of implement such as the chisel plough and the heavy-duty scarifier. The 'shares of the implements were usually made from steel sheet, their shapes being dictated by ease of manufacture rather than by the quality of work they did. In collaboration with a farmer, he had designed a share of a shape which obviously called for casting and had decided to try nodular iron. Field trials indicated that the as-cast 'shares showed hardly any wear after ten-hours' work when the normal steel ones were nearly at the end of their useful life.

Heat-treatment had been shown to be unnecessary for that particular ground which was reasonably free from tree stumps and large stones, because the as-cast 'shares suffered no damage and, of course, had greater wear-resistance. At the price (in Australian currency) of 1s. 6d. per lb., that particular 'share would cost twice as much as the steel 'share while it would give at least four times the life. With surface hardening, the life would be even more prolonged.

That was one instance where nodular cast iron had brought about both better-quality work and longer working-life. There must be many others in the range of tillage implements.

(To be continued)

AT THE Association of Supervisory Electrical Engineers Exhibition (Earls Court, March 15 to 19) the General Electric Company, Limited, is displaying a comprehensive range of industrial equipment, including general-purpose industrial motors and others developed specially for lift and marine application. New fractional horse-power motors to comply with B.S.2048: 1953 are displayed as well as switchgear of many types, particularly cubicles—with fully-enclosed-and-protected air-break switchgear—developed for industrial applications.

THE FIRST CONFERENCE on the development of the automatic factory will be held at Margate in June, organized by the Institution of Production Engineers. The Institution hopes that the conference will show that more machinery, far from displacing workers, would give greater opportunities for all. The progress made in the last ten years in the car industry told its own story in terms of higher productivity, greater employment of workers and more exports. The chairman of the conference organizing committee is Major-Gen. K. C. Appleyard.

Company News

CROSTHWAITE FURNACES & SCRIVEN MACHINE TOOLS, LIMITED—A two-for-five free scrip issue is proposed to be made to holders of the existing £50,000 one-class capital from general reserve capitalization.

CLARKE, CHAPMAN & COMPANY, LIMITED, marine and electrical engineers, boilermakers, etc., of Gateshead—A 20 per cent. dividend is maintained in respect of 1954, but is on an ordinary capital raised to £720,000 by a 50 per cent. scrip issue.

GLOVER & MAIN, LIMITED, gas heating and cooking engineers, of London, S.W.1—The directors propose, subject to Treasury consent, to increase the authorized capital to £1,500,000, sub-divide the existing £1 ordinary shares into 10s. shares, and make a 100 per cent. scrip issue.

INTERNATIONAL COMBUSTION AFRICA, LIMITED—The company is raising the dividend on its £200,000 ordinary capital by 10 per cent. to 40 per cent. for the year to September 30 last. A final of 25 per cent. (20 per cent.) is recommended. The paid interim was also 5 per cent. higher at 15 per cent.

VONO INDUSTRIAL PRODUCTS, LIMITED—Underwriters have been called upon to take up approximately 98 per cent. of the 1,050,000 5 per cent. £1 cumulative preference shares recently offered to shareholders. Renounceable letters of allotment were posted on February 28, and dealings began the next day.

WILLIAM BEARDMORE & COMPANY, LIMITED—Group manufacturing and trading profits of the company, which is a subsidiary of the Iron and Steel Holding and Realization Agency, contracted from £681,521 to £372,798 in the year ended October 2, 1954. The ordinary annual dividend is again brought up to 17½ per cent. with the recommendation of a final of 11¾ per cent., the balance forward being increased from £305,810 to £331,423.

ALFRED HERBERT, LIMITED, machine-tool makers, of Coventry—The company announces a further dividend of 3½ per cent. to make a 6 per cent. tax-free total for the year ended October 31, 1954, on a trebled ordinary capital. No further dividend will be recommended for the year. For the previous 12 months ordinary shareholders received 12½ per cent. tax free before the 200 per cent. scrip issue. Trading profits fell by £256,868 from £3,072,292 to £2,815,424.

STEEL & COMPANY, LIMITED, engineers, etc., of Sunderland—In declaring an interim dividend at 5 per cent., as previously, but on ordinary capital raised to £750,000 by a 50 per cent. free issue, the board points out it must not necessarily be assumed that for the year ending March 27 the final could also be maintained at last year's percentage rate. For that year the final payment was 15 per cent., making a total equivalent to 13½ per cent. on the present equity.

POWER-GAS CORPORATION, LIMITED—Although group trading profits for the year ended September 30, 1954, revealed a slight decline from £765,737 to £760,289, the board considers that the results showed satisfactory progress, having regard to the temporary period of disturbance that has accompanied the extension and equipment of the new South Works at Stockton. For the second year in succession the total value of orders received by the group shows a decline at £5,500,000, compared with £6,250,000. The chairman, Mr. N. E. Rambush, states that any downward trend, however, would appear to be arrested, for during the first quarter of the current year orders to the value of £4,250,000 have been booked.

Book Review

Forge and Foundry by S. E. Ellacott. Published by Methuen & Company, Limited, 36, Essex Street, London, W.C.2. Price 8s. 6d.

This is a story book and makes no pretence to being a textbook for the use of students. Its object is to give the layman an insight into the history of some phases of metallurgy. In the early parts, tin and copper have their place, but later it is confined to iron and steel. The Author has also been the illustrator and whilst in general the pictures are good, the one illustrating the earliest casting now in existence does not do justice to his subject. The figure took the form of a frog and was cast in Mesopotamia about 3,000 B.C. The Author-artist has omitted the stalk carrying a lotus flower attached to the frog's neck. Moreover, he has given insufficient appreciation of the artistic merit of the casting. The Author has been wise in dealing with the casting of bells and guns, for not only are these familiar to the man-in-the-street, but they illustrate interesting methods of manufacture. This type of book could be written by a dozen different authors, each of whom would stress certain factors and processes. Others would have included malleable cast iron and the lost-wax process, but would probably not have given such an excellent description of simple moulding.

It is not a book we can recommend to our readers—presumably being skilled in foundry practice, but as a a gift to apprentices and the like, it has much merit. Undoubtedly, it will interest them in the history of their craft.

V. C. F.

New Catalogues

Arc Furnaces. G. W. B. Furnaces, Limited, Dibdale Works, Dudley, Worcs., has used colour to very good effect in its latest brochure covering Tagliaferri electric-arc furnaces. A picture showing charging is particularly good, though the points of the electrodes might have appeared more realistic had they carried a lighter shade of red and perhaps the picture facing the section "top-charging furnaces" is better from this angle. The brochure covers three types of construction—hand-charged, lift-and-swing-aside roof and bridge-type furnaces. For each a table of data is given and it is interesting to note that the largest goes up to a capacity of 80 tons. The furnaces described are of modern construction and the firm has a wealth of experience available, as no fewer than 450 furnace installations have been made. This outstanding brochure is available to our readers on writing to Dibdale Works.

Unit Dust Collectors. In publication No. 6506, the Sturtevant Engineering Company, Limited, Southern House, Cannon Street, London, E.C.4, illustrates and describes the Uniclone dust collector for use in situations where distance or spacing make the installation of a central plant impracticable. The unit can be mounted on a trolley to suit certain duties. Copies of the leaflet are obtainable on application to Southern House.

Electrodes. The Metropolitan-Vickers Electrical Company, Limited, Trafford Park, Manchester 17, has just issued a pocket guide, which lists essential data for about 30 different types of welding electrodes. Three sorts are detailed for cast iron. Reference is made easy by cutting back the edges of the pages to form labelled sections. It is available from Trafford Park.

BORAX & CHEMICALS, LIMITED, announces that prices for "Three Elephant" brand borax and boric-acid products will be advanced by £1 10s. per ton on April 1.

Personal

Mr. MARTIN MADDAN has resigned as market research manager of the General Electric Company, Limited.

Mr. GEORGE HARSANT, a compass maker, who has been with Kelvin & Hughes, Limited, for over 56 years, has received a presentation on his retirement.

Mr. W. H. L. HARRISON, managing director of the Great Bridge Foundry group at Tipton, has been co-opted to the board of the Walsall Football Club.

Sir SEYMOUR HOWARD, Lord Mayor of London, has been appointed a director of Millspaugh, Limited, papermaking-machinery manufacturers, etc., of Sheffield.

THE RESIGNATION OF PROF. T. U. MATTHEW from the Lucas Chair of Engineering Production at Birmingham University has been accepted, with effect from August 15.

THE MINISTRY OF SUPPLY announces that Mr. C. J. CARTER has been promoted to deputy chief scientific officer and has been appointed director of instrument research and development.

Mr. B. W. JAMES, head of the progress department at the Allen Everitt Works of ICI, Limited, Smethwick, received presentations on his retirement at the end of February after 45 years' service with the company which he joined in 1909.

Sir JOHN COCKCROFT, FRS, director of the Atomic Energy Research Establishment, Harwell, and Prof. D. E. INNES, Emeritus Professor of Geology at St. Andrew's University, will receive the honorary degree of Doctor of Law at the university in July.

Sir LESLIE BOYCE, the former Lord Mayor of London, is reported to be "out of danger and to be progressing well," having been taken ashore seriously ill at Rio de Janeiro last week. Sir Leslie is chairman of the Gloucester Railway Carriage & Wagon Company, Limited, and of the associated companies.

Mr. J. G. WIDDOWSON has been appointed managing director of the Neepsend Steel & Tool Corporation, Sheffield, in place of Sir STUART C. GOODWIN, who has resigned the post but retains the chairmanship of the company. Mr. F. K. GARDINER has been appointed a director and deputy chairman of the Corporation from March 1, and Mr. HAROLD KIPPAX has been appointed a director as from May 16.

Mr. T. A. MCKENNA, chairman and joint managing director of the Staveley Coal & Iron Company, Limited, has resigned his office as joint managing director, but will continue in an executive capacity as chairman. Mr. J. P. HUNT, joint managing director, has been appointed managing director. Mr. M. FROGGATT, director and secretary, has resigned as secretary to the company and has been appointed deputy managing director. Mr. H. M. EARNSHAW, assistant secretary, has been appointed secretary.

Mr. ARNOLD RIMMER, head of the mechanical engineering department of Derby Technical College, is to retire at the end of the year. In his engineering career he has been associated with the Premier Gas Engine Company, of Sandiacre, and later with Rolls-Royce, Limited, Derby. In 1920 he returned to Liverpool University as a lecturer, and in 1925 became a lecturer at Derby Technical College, being appointed head of the Mechanical Engineering Department in 1927. Mr. Rimmer is president of the Derby Society of Engineers.

THE FOLLOWING APPOINTMENTS have been made in the English Steel Forge & Engineering Corporation, Limited, Sheffield. Mr. G. E. G. GILFILLAN, adviser on engineering production; Mr. R. W. BROCKLEHURST, production superintendent, forge products; Mr. H. COWLISHAW, production superintendent, heavy plate department products; Mr. H. WILSON, forge products machine shop manager. Mr. E. LEVESLEY, assistant manager, forge products machine shops; Mr. G. WILSON, drop forge manager (extra duties); Mr. R. T. LEE, production manager, River Don and Attercliffe drop forges.

THE IRON AND STEEL TRADES EMPLOYERS' ASSOCIATION of Great Britain has as its new president Mr. J. H. PATCHETT, a special director and superintendent of production of Dorman, Long & Company, Limited. For the past three years he has been vice-president and is chairman of the North-East Coast Division of the association. Since 1946, Mr. Patchett has been the employers' chairman of the Allied Craftsmen's Joint Committee. A member of the council of the British Iron and Steel Research Association, he is also a past-president of the Cleveland Scientific and Technical Institution and of the Cleveland Institution of Engineers.

Obituary

Mr. FRANK GREENWOOD, who has died at the age of 58, was a director of Greenwood & Company (Todmorden), Limited, mill furnishers and shuttle manufacturers.

Mr. D. H. MONTGOMERY, Continental manager of E. W. Bliss (England), Limited, manufacturers of power presses, can-making machinery, etc., of Derby, died recently.

Mr. CHARLES W. TAIT, who has died at the age of 70, was secretary and a director of the Lawside Engineering & Foundry Company, Limited, Dundee. For eight successive years he was a member of the Scottish international bowls team.

Mr. NORMAN HADDON, a director of the Metropolitan Cammell Carriage & Wagon Company, of Saltley, Birmingham, collapsed and died while attending a meeting on February 23 at Richard Thomas & Baldwins, Limited, in London. He was 55.

Mr. HENRY SWINNERTON, who has died after a long illness, was chairman and managing director of Francis W. Harris & Company, Limited, manufacturers of mine and electrical equipment, etc., of Burslem, Stoke-on-Trent. He was also chairman of the Harris Motor Company, Limited.

Mr. JOHNSTON HUGHES, who died on February 26 at the age of 90, was from 1894 to 1911 shipyard manager of Harland & Wolff, Limited, Belfast. He joined the company as an assistant shipyard manager in 1886 and after his retirement, for health reasons, acted in a confidential capacity for Lord Pirrie, then chairman of the company.

SIR STEPHEN PIGOTT, managing director of John Brown & Company, Limited, at Clydebank, from 1938 until his retirement in 1948, died on February 27 at his home in Dumfriesshire at the age of 75. He was one of the leading figures in marine propulsion and construction and had been associated with the Clydebank shipbuilding yard since 1909. Born in Cornwall, New York, he came to this country in 1908 when he was invited to join John Brown & Company, Limited. He soon became known as an engineer who could be entrusted with work on a large scale and among the liners he helped to produce were the two "Queens," the Lusitania, Aquitania, and the Empress of Britain.

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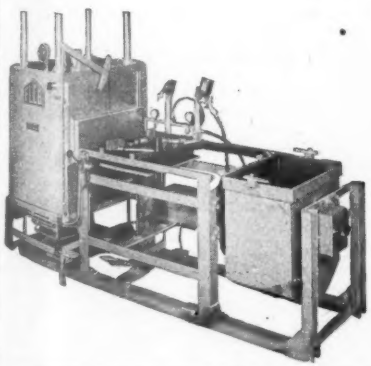

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AP 236-73

News in Brief

IN AN ARTICLE which Mr. W. Y. Buchanan wrote for the *Glasgow Herald Trade Review*, he suggested that nodular cast iron should be called Morrogh's cast iron.

WHITING CORPORATION has opened a branch office at University Tower Building in Montreal. Many components are now being manufactured in Canada.

MR. D. F. CAMPBELL, chairman of the Electric Furnace Company, Limited, recently presented gold watches to nine members of the staff for service with the EFCO group of companies for 25 years or more.

OPENING a new office in Vancouver, Mr. J. M. Sinton, managing director of the Coseley Engineering Company, Limited, Wolverhampton, announced that the company would form a subsidiary in Canada.

MACHINERY which is being made for hydro-electric schemes in north Scotland and overseas was shown to members of the Council of British Manufacturers of Petroleum Equipment when they visited the works of Bruce Peebles, Limited. Edinburgh.

THE BOARD OF TRADE announces that firms which are required to make a census of production return for 1955 have already been notified in advance and that the Statutory Advisory Committee for the censuses for 1956 and 1957 has now been appointed.

A FAIR will be organized in 1958 by the National Industrial Development Council of Wales and Monmouthshire, which has handled the Welsh Industries Fair for the past 23 years. In 1958 the Commonwealth and Empire Games are due to be held in Wales.

IT HAS BEEN IMPOSSIBLE to achieve the object in view, state the boards of Thomas De La Rue & Company, Limited, and Sidney Flavel & Company, Limited, announcing that the negotiations to merge their interests in gas, solid-fuel, and heating appliances have terminated.

THE DERBY SECTION of the National Trades Technical Societies organized a programme of films of interest to foundrymen and technicians, which was shown at Derby College of Art. It is hoped to reform a Foundry Society in Derby; the programme was attended by 80 members.

THOUSANDS OF POUNDS' worth of damage was caused by a fire which practically gutted the four-storey building of Husbands, Hart & Warburton, Limited, electrical engineers and brass and aluminium founders, at its City Road Works, Derby. Arrangements have been made to carry on business.

UNITED STEEL COMPANIES, LIMITED, Sheffield, has asked Sheffield City Council to sanction the use of a flat field at Jordanthorpe Farm, Norton, Sheffield, as an airfield to operate an Auster aeroplane owned by the company. The firm already has facilities for landing near its works and sales centres other than at Sheffield.

UNITED KINGDOM EXHIBITORS at the forthcoming international fairs at Utrecht, Milan, Brussels, Gothenburg, and Toronto are invited to call at the stands which the Board of Trade is installing to discuss any problems which may arise as a result of their participation in the fairs, or to seek advice on trade with the countries concerned.

A CONDITIONAL OFFER to purchase for £5,000,000 the undertaking and assets of Petrochemicals, Limited, has been made by Shell Chemicals, Limited (Distributors). The Petrochemicals board urges shareholders to accept the offer. The Finance Corporation for Industry, Limited, has agreed to accept £4,352,935 to cover the whole of its substantial interests in Petrochemicals.

THE Pulsometer Engineering Company, Limited, Reading, has appointed S. W. Carty & Son, 12, Lower Mount Street, Dublin, as its agent for Eire for pumps of all types and refrigeration and water purification plant, with the exception of aircraft fuel pumps, vacuum pumps, and oil refining pumps. S. W. Carty & Son succeeds Mr. H. M. Moore as the company's agent.

NORTHIDE, LIMITED, of Impervia Works, Queen Street, Stockport, is exhibiting the complete range of North fabric-supported PVC protective gloves and clothing at the Factory Equipment Exhibition, March 28 to April 2, on stand G.4. In addition, PVC boots, which are resistant to oils and chemicals, and new fire-fighting garments of metalized fabric with good heat-reflecting qualities, will be exhibited.

A FLEET of modern streamlined refrigerator vans, valued at £250,000, is to be shipped to Yugoslavia under a contract which has just been signed between Leyland Motors, Limited, and the "Yugostrov" Refrigerating Plant Equipment Factory, near Belgrade. The vans, which vary from 700 to 1,200 cub. ft. capacity, will help Yugoslavia's export drive to neighbouring Continental countries by carrying pre-frozen meat and soft fruits.

PATTERNMAKERS at the Wednesbury steel foundry of F. H. Lloyd & Company, Limited, had to give urgent priority to Ark Royal work when designs for special steel castings were received by the company. More than 100 patterns were needed. They were for the steam bends and valve connections for the main machinery. The castings, weighing about 40 lb. each, had to be pressure-tight and fully finished before they left the foundry.

BIRLEC, LIMITED, announces that the firm has recently been commissioned by the Head Wrightson Machine Company, Limited, Middlesbrough, to build a continuous driven-roller hearth-annealing and galvanizing furnace for installation at a South Wales steelworks. This equipment will be the largest heat-treatment plant of this type yet undertaken by Birlec, Limited, and it will handle steel strip of up to 48 in. width at an output of 10 tons per hour.

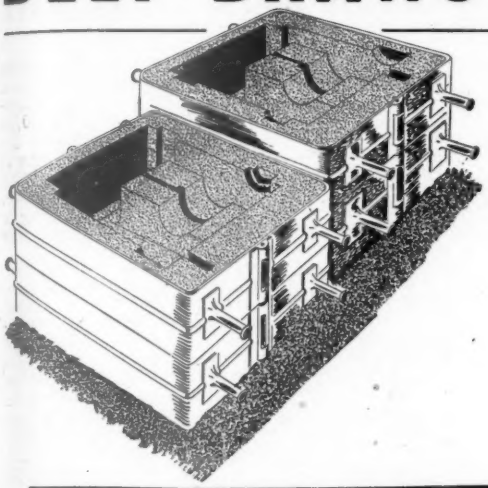
MR. R. C. WOODWARD, secretary of the Birmingham branch of the Purchasing Officers' Association, said on March 2 that difficulty over nickel supplies was the most serious aspect of the raw materials shortage in the Midlands. Supplies are inadequate to deal with the increased business being offered. The Economic Survey Committee of the association reports also shortages of sheet steels, copper and secondary metals, structural steel sections and tubing, re-rolled steel strip and bar.

EXHIBITS of Kelvin & Hughes (Industrial), Limited, at the National Factory Equipment Exhibition (to be held at Earls Court from March 28 to April 2) will include on stand G.26 draught gauges; an econometer (a new instrument which provides information necessary for maximum fuel economy conditions to be maintained in a boilerhouse); an electronic controller; multipoint temperature indicator; circular chart recorder; and a multiline recorder for gas analysis and temperature measurement.

THE ROYAL SOCIETY OF ARTS announces amongst those receiving bursaries for the 1954 Industrial Art Competition are:—For the Domestic Gas Appliances section—Mr. John Lincoln Fagg (Kingston School of Art), Domestic Solid Fuel Burning Appliances—Mr. Thomas Alan Burke (Birmingham College of Arts and Crafts). The bursaries amount to £150. The winning

(*Continued on page 276*)

DEEP DRAWS . . .



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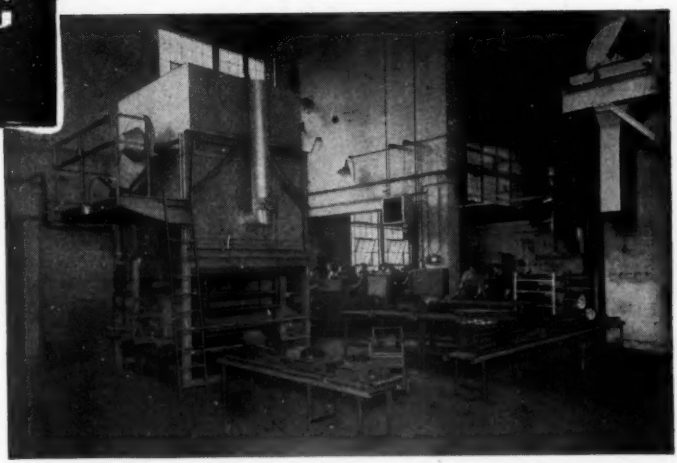

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J.T.L.

News in Brief

(*Continued from page 274*)

entries of all the sections will be shown at an exhibition to be held at the Society's House, 6 to 8, John Adam Street, Adelphi, London, W.C.2, from May 16 to 28.

PHILIPS RESEARCH LABORATORIES has concluded a series of developments leading to the manufacture of an entirely new gas refrigerating machine that can be used to produce liquid air. Philips Electrical, Limited, in announcing the liquid air installation PW7000, state that temperatures of − 200 deg. C. can be obtained quickly and simply. The plant also has distinct advantages over more orthodox compression refrigerators which, ordinarily, are unable to produce temperatures lower than between −60 and −80 deg. C.

SIR HARRY PILKINGTON, president of the Federation of British Industries, said at Leicester on March 2 that he would oppose any return to austerity as a policy. He told FBI members in the North Midland region: "The Chancellor has removed any fear of immediate inflation and, by showing he will resolutely act has greatly reduced the danger of speculation in the future." If the Bank Rate was used as a flexible means of varying the cost of finance, the present temporary rate was not a check to people who looked ahead."

C. & J. HAMPTON, LIMITED, Record Tool Works, Sheffield, presented long-service awards to employees on February 28. Recipients of awards became members of the Record Club which was founded in 1948, the year of the firm's jubilee. Membership is restricted to those who have worked 30 years with the firm. Mr. Charles W. Hampton, chairman and managing director, presenting the awards, emphasized the importance of carrying on the family tradition among the work people. The new members bring the club membership up to 80.

THE BIRMINGHAM PRODUCTIVITY ASSOCIATION is sponsoring an exhibition entitled "Productivity for the Small Firm," to be held from March 18-28. Only inexpensive equipment will be on show because the aim of the exhibition is to counter the belief that increasing productivity calls for high capital outlay. No item exhibited will cost more than £200. The Lord Mayor of Birmingham will open the exhibition and Sir Harry Pilkington, president of the Federation of British Industries, and Mr. A. B. Waring, chairman of the B.P.A., will give an address.

AS A MEMENTO of the long association of the Horsehay Company with Dawley Urban District Council, three directors of the firm, Mr. A. H. Simpson, Mr. A. V. Flynn and Mr. H. P. Bullock, are to present the Council with a chairman's badge of office. Announcing this at the council meeting on March 2, Mr. Bullock said the association started in 1894 when the founder of the firm, Mr. H. C. Simpson, was Council chairman. Another local industrialist and councillor, Mr. J. T. M. Johnston, stated that he would present the Council with a chairman's seat.

BIRMINGHAM UNIVERSITY is to institute a general course on radioactivity and the handling of radioactive materials leading to the degree of Master of Science by examination, it was announced on March 2. The development has been planned by the Department of Physics and the director of the department, Prof. P. B. Moon, hopes that the first course will begin in October next. It will be the first course of its kind in the country leading to a degree, although short courses have been in operation at the Atomic Research Establishment at Harwell for some time.

HENRY WIGGIN & COMPANY, LIMITED, is showing on stand 169 at the Electrical Engineers' Exhibition a new grade of nickel/chromium alloy for high-temperature furnace resistors. This alloy is a modified 80/20 nickel/chromium alloy Brightray "H," intended for use as a heating element in electric-resistance furnaces where the element operating temperature exceeds that for which Brightray "S" grade is normally suitable. The new grade is intended for elements operating in the temperature range 1,100 to 1,250 deg. C. It is now in production in the form of rod, wire and strip.

A CONTRACT for the manufacture and supervision of the erection of 16 large water turbines—each rated at 75,000 h.p.—has been awarded by the Hydro-Electric Power Commission of Ontario to the John Inglis Company, Limited, Toronto, the Canadian associates of the English Electric Company, Limited. The turbines will be built as part of the St. Lawrence power project and the contract awarded covers the complete turbine installation on the Canadian side. The New York State Power Authority has signed a contract with the General Electric Company, of New York, for 16 generators for the American half of the project.

BRITISH THOMSON-HOUSTON COMPANY has just received a contract valued at £4,100,000 for development and production of military electronic equipment for supply to NATO countries. The contract has been negotiated with Hazeltine Electronics Corporation, of New York City, acting on behalf of the United States Navy Department. The total value of US Government orders now placed with BTH for military electronic equipment, including fire control, radar, etc., amounts to £9,200,000. In addition, BTH has in the past five years supplied to European and Commonwealth countries direct £6,000,000 worth of military radar apparatus.

THE SCOTTISH BOARD FOR INDUSTRY has urged the British Transport Commission to place orders in Scotland for a substantial share of the coachbuilding, locomotive, and wagon construction, and other incidental work which will be involved in the railways modernization programme, Mr. Charles Murdoch, chairman of the Board, said at a conference in Glasgow on March 2. It was possible, he added, that the coachbuilding work might lead to some extent to a revival of vehicle building in Scotland, which at present was very much in the decline. An attempt is also being made to obtain priority status in the modernization scheme for the Glasgow district, the Clyde Valley, and the Edinburgh-Glasgow route, on the grounds of density of traffic.

THE BIRMINGHAM PRODUCTIVITY ASSOCIATION is turning its attention to apprentice recruitment and is arranging a fact-finding visit to West German industrial centres by a team of experts, to study the working of the German apprenticeship training schemes. A party of six will be drawn equally from management, the unions and education. The visit, beginning on March 13, and lasting a fortnight, will include visits to such factories as the Opel works at Ruesselshelm, the Leitd works at Wetzlar, the Henkel works, the Bayer factory and two steelworks in the Ruhr. In Germany, it is stated that only 22 per cent. of school leavers take up unskilled work, so that 78 per cent. are given planned training—probably more than twice the percentage in this country.

Underground movement

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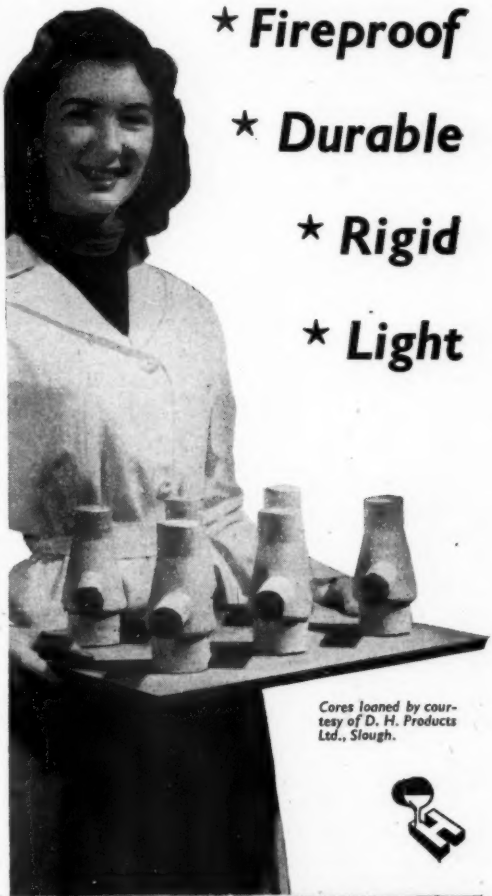

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Raw Material Markets

Iron and Steel

Foundrymen welcome the disclosure in the Iron and Steel Board's latest report that an "adjustment" of blast-furnace outputs is under consideration to meet the heavy requirements of low-phosphorus foundry iron for the production of automobile and other engineering castings, together with the provision of more efficient plant for the manufacture of foundry and hematite iron generally.

Hitherto, the expansion of pig-iron production has been almost wholly devoted to the needs of the steel plants, but bigger outputs of other grades of iron have become an urgent necessity to sustain the mounting activity of the foundry trades. Unfortunately, current shortages have been accentuated by snowbound transport. Deliveries have been interrupted and stocks of iron depleted.

Supplies of the low- and medium-phosphorus irons are very scanty, and the resultant demand for hematite pig-iron to fill the gap has forced producers to ration supplies so that an equitable distribution of available tonnages may be obtained. Increased quantities of the low- and medium-phosphorus irons appear to be out of the question, and with hematite makers heavily committed for some weeks ahead there seems little prospect of obtaining larger supplies of that grade. To improve their supply position a big demand is being made on Scottish producers of the lower phosphorus irons by foundries in the English Midlands and further south, while some have booked consignments of imported iron to tide them over this stringent period. Refined-iron makers also have good demands for their production.

Jobbing foundries are busy and the light and textile foundries maintain improved outputs of castings. Demands for high-phosphorus pig-iron take up all available supplies and most makers have heavy order-books.

The scarcity of scrap continues in most areas, particularly as regards heavy cast-iron and machinery scrap, and this adds to the difficulties of the foundries, as a larger percentage of pig-iron is required in their mixtures. Foundry coke is being sent forward up to allocated tonnages, but delays *en route* have resulted in many cases in the liquidation of stocks.

The intake of steel semis is a source of constant anxiety to the re-rollers. Last year there was a dearth of orders for re-rolled bars and sections and billet requirements could be readily satisfied. Now the position is wholly reversed. All the mills have substantial rolling programmes, but the steel-makers cannot provide the increased tonnages of semi-finished steel which are required. Nor is it easy to buy abroad. A few shipments have arrived, but they are insufficient to afford other than partial relief, and until more liberal supplies are obtainable operation of the mills must be precarious.

The severe weather has imposed serious difficulties upon steel producers, interrupting both the assembly of raw materials and the clearance of finished products, but given more favourable conditions the industry is hoping to reduce the arrears in deliveries.

The demand for sheets can only be satisfied by the augmentation of home production with substantial imports, but impressive tonnages of joists, channels, etc., are now being turned out and a progressive rise in production should enable the makers to meet more successfully the numerous appeals for supplies, although it may be some time before works are able to accept further business, even for forward deliveries.

Non-ferrous Metals

With the settlement of the Copperbelt strike last week, the Northern Rhodesian copper industry is tackling the task of getting the men back into active employment, and production under way again. Fortunately, this had never ceased, although it was reduced to about 50 per cent. of normal at one stage until it was raised to over 65 per cent. eventually. Whether such a large labour force as that employed before the strike will now be required seems doubtful. Unfortunately, the Northern Rhodesian European Mineworkers' Union on the Copperbelt does not seem to be very well pleased with the terms of the settlement, but, on the whole, there is a feeling of relief that the long drawn-out dispute has been brought to a conclusion.

Initially the copper market advanced after the news had come through, but subsequently prices fell away and prompt metal at one time was down to £335. At the close, cash had improved again, but, even so, was £2 down on the week, while three months finished £5 down. Consumer demand was not very rewarding, but some Continental inquiry was evident.

Tin lost ground to the extent of £6 for cash and £5 10s. for three months, but there does not seem to be any inherent weakness in this metal. A contango seems now to be firmly established in tin, which at the end of last week stood at £4. In both lead and zinc a firmer trend was apparent, but at one time zinc looked rather weak. On balance, both positions for zinc gained 10s., while in lead prompt was up 10s., but forward was unchanged, the backwardation widening to £1. The reappearance of a premium in lead for the prompt position is hardly acceptable and, for the most part, inexplicable, for there is no lack of lead in the UK and shipments are coming forward freely.

Official metal prices were as follow:—

COPPER, Standard—*Cash:* March 3, £340 10s. to £341 10s.; March 4, £339 to £340; March 7, £340 to £341; March 8, £343 to £344; March 9, £343 10s. to £344.

Three Months: March 3, £328 to £329; March 4, £324 to £325; March 7, £325 to £325 10s.; March 8, £327 10s. to £328 10s.; March 9, £330 to £330 10s.

TIN, Standard—*Cash:* March 3, £708 to £709; March 4, £706 to £707; March 7, £708 to £709; March 8, £706 to £707; March 9, £709 to £710.

Three Months: March 3, £713 to £714; March 4, £711 to £712; March 7, £712 to £712 10s.; March 8, £709 to £710; March 9, £712 10s. to £713.

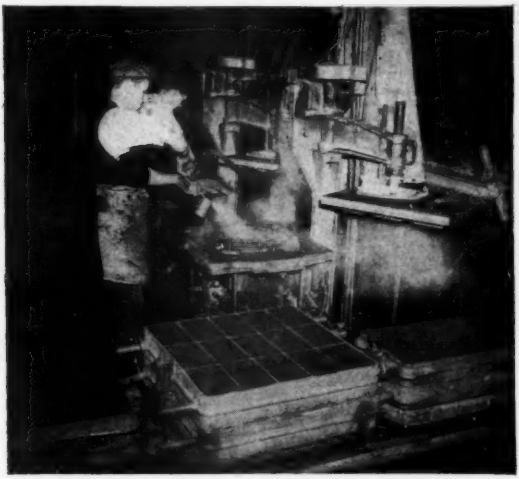
LEAD—*First half March:* March 3, £103 to £103 10s.; March 4, £102 15s. to £103 5s.; March 7, £103 5s. to £103 10s.; March 8, £102 15s. to £103; March 9, £103 10s. to £104.

First half June: March 3, £102 5s. to £102 10s.; March 4, £101 15s. to £102; March 7, £102 5s. to £102 10s.; March 8, £101 15s. to £102; March 9, £102 10s. to £102 15s.

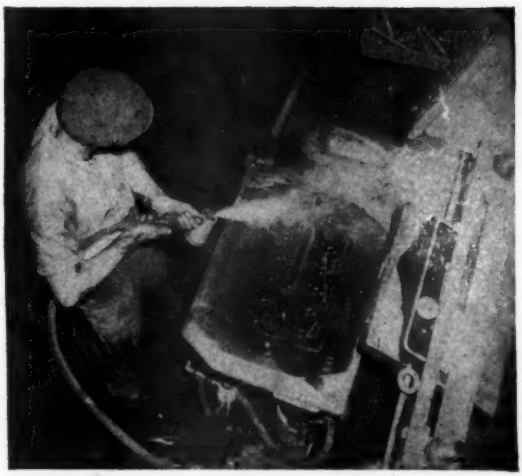
ZINC—*First half March:* March 3, £87 5s. to £87 10s.; March 4, £86 15s. to £87; March 7, £86 15s. to £87 5s.; March 8, £87 to £87 10s.; March 9, £87 15s. to £88.

First half June: March 3, £87 to £87 5s.; March 4, £86 10s. to £86 15s.; March 7, £86 10s. to £86 15s.; March 8, £86 10s. to £86 15s.; March 9, £86 15s. to £87.

THE Government of India has invited a UK technical mission to visit India in connection with the British Government's offer of collaboration, under the Colombo Plan, in setting up a steel plant, states a New Delhi report.



Illustrations of "PLP" in use by courtesy of Messrs. Henry Wallwork & Co. Ltd., Red Bank, Manchester.



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Current Prices of Iron, Steel, and Non-ferrous Metals

(Delivered unless otherwise stated)

March 9, 1955

PIG-IRON

Foundry Iron.—No. 3 IRON, CLASS 2:—Middlesbrough, £15 12s. 0d.; Birmingham, £15 5s. 3d.

Low-phosphorus Iron.—Over 0.10 to 0.75 per cent. P, £17 13s. 9d., delivered Birmingham. Staffordshire blast-furnace low-phosphorus foundry iron (0.10 to 0.50 per cent. P, up to 3 per cent. Si), d/d within 60 miles of Stafford, £18 9s. 3d.

Scotch Iron.—No. 3 foundry, £18 2s. 3d., d/d Grangemouth.

Cylinder and Refined Irons.—North Zone, £20 4s. 0d.; South Zone, £20 6s. 6d.

Refined Malleable.—P, 0.10 per cent. max.—North Zone, £21 1s. 6d.; South Zone, £21 4s. 0d.

Hematite.—Si up to 2 per cent., S. & P. over 0.03 to 0.05 per cent.:—N.-E. of England (local iron), £18 2s. 6d.; Scotland (Scotch iron), £18 9s. 0d.; Sheffield, £19 7s. 6d.; Birmingham, £19 14s. 6d.; Wales (Welsh iron), £18 9s. 0d.

Basic Pig-iron.—£15 15s. 6d. all districts.

FERRO-ALLOYS

(Per ton unless otherwise stated, delivered)

Ferro-silicon (6-ton lots).—40/55 per cent., £40 15s. 0d., basis 45 per cent. Si, scale 15s. per unit; 70/84 per cent., £63 0s. 0d., basis 75 per cent. Si, scale 16s. per unit.

Ferro-vanadium.—50/60 per cent., 23s. 8d. to 25s. 0d. per lb. of V.

Ferro-molybdenum.—65/75 per cent., carbon-free, 11s. 0d. per lb. of Mo.

Ferro-titanium.—20/25 per cent., carbon-free, £161 0s. 0d. to £165 0s. 0d. per ton; 38/40 per cent., £258 0s. 0d. to £262 0s. 0d. per ton.

Ferro-tungsten.—80/85 per cent., 17s. 5d. per lb. of W.

Tungsten Metal Powder.—98/99 per cent., 20s. 5d. per lb. of W.

Ferro-chrome (6-10 ton lots).—4/6 per cent. C, £78 0s. 0d. to £80 0s. 0d., basis 60 per cent. Cr, scale 25s. 0d. per unit; over 6 per cent. C, £76 0s. 0d. to £78 0s. 0d., basis 60 per cent. Cr, scale 24s. 0d. per unit; 2 per cent. C,* 1s. 8½d. per lb. Cr; 1 per cent. C,* 1s. 9d. per lb. Cr; 0.15 per cent. C,* 1s. 10½d. per lb. Cr; 0.10 per cent. C,* 1s. 10¾d. per lb. Cr; 0.06 per cent. C,* 2s. 0d. to 2s. 3d. per lb. Cr.

Metallic Chromium.—98/99 per cent., 6s. 6½d. to 7s. 1d. per lb.

Metallic Manganese.—93/95 per cent., carbon-free, £225 0s. 0d. to £232 0s. 0d. per ton; 96/98 per cent., £255 0s. 0d. to £262 0s. 0d. per ton.

Ferro-columbium.—60/75 per cent., Nb + Ta, 52s. 6d. to 70s. 0d. per lb., Nb + Ta.

Ferro-manganese (home).—78 per cent., £54 15s. 0d.

SEMI-FINISHED STEEL

Re-rolling Billets, Blooms, and Slabs.—BASIC: Soft, u.t., £25 5s. 0d.; tested, 0.08 to 0.25 per cent. C, £26 5s. 0d.; hard (0.41 to 0.60 per cent. C), £27 10s. 0d.; silico-manganese, £34 10s. 0d.; free-cutting, £29 6s. 6d. SIEMENS MARTIN ACID: Up to 0.25 per cent. C, £32 17s. 0d.; silico-manganese, £34 10s. 0d.

Billets, Blooms, and Slabs for Forging and Stamping.—Basic, soft, up to 0.25 per cent. C, £29 13s. 6d.; basic, hard, over 0.41 up to 0.60 per cent., C, £30 16s. 0d.; acid, up to 0.25 per cent. C, £33 15s. 0d.

FINISHED STEEL

Heavy Plates and Sections.—Ship plates (N.-E. Coast), £31 1s. 6d.; boiler plates (N.-E. Coast), £33 11s. 6d.; floor plates (N.-E. Coast), £32 10s. 6d.; sectional material, N.-E. Coast, £29 4s. 6d.

Small Bars, Sheets, etc.—Rounds and squares, under 3 in., untested, £31 19s. 6d.; flats, 5 in. wide and under, £31 19s. 6d.; hoop and strip, £33 1s. 6d.; uncoated strip mill coils, hot rolled, under 3mm. to 12g., £34 5s. 0d.; black sheets (hand mill), 17/20 g., £43 13s. 6d.; galvanized corrugated sheets, 24 g., £55 4s. 0d.

Alloy Steel Bars.—1 in. dia. and up: Nickel, £54 7s. 9d.; nickel-chrome, £76 7s. 9d.; nickel-chrome-molybdenum, £86 8s. 6d.

NON-FERROUS METALS

Copper.—Cash, £343 10s. 0d. to £344 0s. 0d.; three months, £330 0s. 0d. to £333 10s. 0d.; settlement, £344 0s. 0d.

Copper Tubes, etc.—Solid-drawn tubes, 3s. 3½d. per lb.; rods, 385s. 3d. per cwt. basis; 20 s.w.g., 416s. 6d. per cwt.

Tin.—Cash, £709 0s. 0d. to £710 0s. 0d.; three months, £712 10s. 0d. to £713 0s. 0d.; settlement, £710 0s. 0d.

Lead (Refined Pig).—First half March, £103 10s. 0d. to £104 0s. 0d.; first half June, £102 10s. 0d. to £102 15s. 0d.

Zinc.—First half March, £87 15s. 0d. to £88 0s. 0d.; first half June, £86 15s. 0d. to £87 0s. 0d.

Zinc Sheets, etc.—Sheets, 15 g. and thicker, all English destinations, £117 10s. 0d.; rolled zinc (boiler plates), all English destinations, £115 5s. 0d.; zinc oxide (Red Seal), d/d buyers' premises, £103 0s. 0d.

Brass Tubes, etc.—Solid-drawn tubes, 2s. 7d. per lb.; rods, drawn, 3s. 4⅛d.; sheets to 10 w.g., 332s. 9d. per cwt.; wire, 3s. 2¼d.; rolled metal, 319s. 0d. per cwt.

Brass (Brazing).—BS1400, B3 (65/35), £215; B6 (85/15), £302; BS249, £238.

Brass (High Tensile).—BS1400, HTB1 (30 tons), £262; HTB2 (38 tons), £276; HTB3 (48 tons), £287.

Gunmetal.—RCH, 3/4 per cent. tin, —; BS1400, LG2 (85/5/5/5), £283; LG3 (86/7/5/2), £295; G1 (88/10/2/¼), £378; (88/10/2/1), £367.

Phosphor Bronze.—BS1400, PB1 (AID released), £388 per ton.

Phosphor Bronze Strip, etc.—Strip, 466s. 9d. per cwt.; sheets to 10 w.g., 489s. 3d. per cwt.; wire, 4s. 8¼d. per lb.; rods, 4s. 1¾d.; tubes, 4s. 0d.; chill cast bars: solids 4s. 1d., cored 4s. 2d. (CHARLES CLIFFORD, LIMITED.)

Nickel Silver, etc.—Rolled metal, 3 in. to 9 in. wide × 0.056, 3s. 11d. per lb.; round wire, 10g. in coils (10 per cent.), 4s. 4¼d.; special quality turning rod, 10 per cent., ½ in. dia., in straight lengths, 4s. 3½d. All prices are net.

Other Metals.—Magnesium, ingots, 2s. 3d. per lb. Antimony, English, 99 per cent., £210 0s. 0d. Quicksilver, ex-warehouse, £109 0s. 0d. to £109 10s. 0d. Nickel, £519 0s. 0d. Aluminium, ingots, £163 0s. 0d.; aluminium bronze (BS1400), AB1, £335; AB2, £345. Solder, brazing, BS1845, 2s. 6d. lb.; granulated, 2s. 9d. lb.

* Average 68-70 per cent.